Syllabus

Master of Business Administration (M.B.A.) 3rd Semester

Course 301

STRATEGIC ANALYSIS

COURSE CONTENTS

MODULE-I : STRATEGIC FRAMEWORK

Introduction to strategy to strategy, strategic planning process, strategic decision-making, business definition, goal setting, policy formation, mission and objectives.

MODULE-II : ANALYSISING RESOURCES, CAPABILITIES AND COMPETENCEIES

Strength and weaknesses, objectives, strategy, structure, finance, marketing, production, human resource, research and development, value chain analysis, benchmarking, the balanced score card, competitive advantage and core competence.

MODULE-III : EXTERNAL ANALYSIS

The environment of the firm, strategic posture, environmental forecasting, customer and competitor analysis.

MODULE-IV : STRATEGIC ALTERNATIVES

Grand strategies, diversification and integration, merger, turnaround, divestment, liquidation and combination strategies.

MODULE-V

Corporate portfolio analysis, industry, competitors and SWOT analysis. Subjective factors in strategic choice.

SUGGESTED READINGS		
1.	Christensen, Andrews, Bower	Business Policy, Text and Cases, Irwin, 1973.
2.	H. lgor Ansoff	Corporate Strategy, Mc Grew Hill, 1974.
3.	H. lgor Ansoff	Readings in Business Strategy.
4.	William T. Gluck	Business Policy—Strategy Formation and Management Action.
5.	Kenneth A. Andrews	Concept for Corporate Strategy.
6.	Bongs & Coleman	Concept for Corporate Strategy.
7.	Newman & Logan	Business Policies and Central Management.
8.	Peter F. Drucker	Management Tasks, Responsibilities, and Practices.
9.	Russell L Ackoff	A Concept of Corporate Planning.
10.	Robert J. Mockler	Business Planning & Policy Formation.
11.	H.N. Brooms	Business Planning & Strategic Action.
12.	Simul C. CArto	Strategic Management.

Syllabus

Master of Business Administration (M.B.A.) 3rd Semester

Course 302

MANAGEMENT INFORMATION SYSTEM

Objective

This course is aimed at to acquaint the students with applications of Information Systems in business world, development life cycle of MIS, its development tools and decision-making.

(i) INTRODUCITON TO MIS

Emergence of MIS; What is MIS, MIS Sub-Systems Role of Computers in MIS; Computer and Management Functions; Computer-based (e.g. Financial Accounting, Inventory Control Personnel and marketing).

(ii) MANAGEMENT AND DECISION MAKING

Decision making, Types of Decisions; Decision-Making Process; Decision-making Techniques O.R. and Management Decision-making, Transportation Models; Assignment Models' PERT/CPM network Analysis.

(iii) SYSTEM DEVELOPMENT

System Definition, Characteristics and Elements of System Role of System Analyst, Overview of System Development Life Cycle (SDLC), Structured Analysis; Data Flow Diagram (DFD), Data Dictionary, Structured English, Decision Table and Tree; Unstructured Analysis; Interview, Review of Literature, On site Observation and questionnaires; Input/Output forms design, Testing, Implementation and Maintenance, Implementation and Control of Projects.

(iv) INTEGRATED COMPUTERS TO INFORMATION SYSTEM

Database Management System (DBMS), types of DBMS, concepts of entities, attributes and relations; Three levels of BDMS, Advantages and disadvantages of DBMS; Data Models (Hierarchical, Network and Relational), Relation of types in entities and attributes; Functional Dependencies; Normalization of Data (1 NF, 2^{nd} NF and 3^{rd} NF), Role of Data Base Administrator (DBA).

Introduction of packages used for development of MIS (only introductory level):

1. RDBMS Packages (back end tools) : ORACLE and MS Access

2. GUI packages (front end tools): Developer-2000, Power Builder, and

Visual Basic

(v) SOCIO-LEGAL ASPECTS OF COMPUTERRISATION

Social dimension of Computerization; Computer Viruses; Computer Crimes, Legal Dimensions of Computerization.

BOOKS RECOMMENED		
1.	Murdick, Ross & Clagget	Information system for Modern Management, Prentice Hall of India.
2.	James A. Serm	Analysis and Design of Information System, MC Graw Hills International.
3.	V. Rajaraman	Analysis and Design of Information Systems, Prentice Hall of India.
4.	E.M. Awad	System Analysis and Design, Galgotia Publications.
5.	M.G. Simkin	Introduction to Computer Information System for Business S. Chand & Company.
6.	James A.O. Briell	Management Information Systems, Galgotia Publication.

SPECIALIZATION-1 (Three Courses)

(Course 304 to 306)

Master of Business Administration (M.B.A.)

MM-01 : MARKETING RESEARCH

OBJECTIVE

The course is intended to help students planning to become marketing executives to develop their thinking about the nature of research in marketing to get acquainted with various research concepts, techniques and procedures, and to develop their ability to conduct, evaluate, sue and present research findings.

COURSE CONTENTS

UNIT-I

Marketing Research-Meaning and Importance. Stages in the Marketing Research Process. Scope of Marketing Research Function. Problem Formulation Choice-Criterion Models.

UNIT-II

Research Design-meaning and Importance. Causality. The Basis of Classification of Various Types of Research Design. Exploratory, Descriptive Quasi-Experimental and Experimental Research Designs.

UNIT-III

Data Collection. Types and Sources of Secondary Data Basic Methods of Collecting Data. Different Methods of Communication. Tabulation, Analysis and Interpretation of Data Questionnaire Planning and Execution.

UNIT-IV

Sampling and Sampling Designs, Basic Concepts. Steps in the Sampling Process. Probability Sampling Methods, Non-Probability Sampling Methods.

UNIT-V

Application of Marketing Research market Segmentation, product Research, Price Research, Distribution Research, Advertising Research, Sales Promotion Research. The Marketing Research Report.

Suggested Readings		
1.	Boyd, Westfall an Stasch	Marketing Research.
2.	Green Tull and Albaum	Research of Marketing Decisions.
3.	Luck and Rubin	Marketing Research

Master of Business Administration (M.B.A.)

MM-02 : ADVERTISING MANAGMENT

Objective

The aim of the paper is to acquaint the students with concepts, techniques and give experience in the application of concepts for a developing and effective advertising programme.

Course Contents

Advertising's Role in the Marketing Process : Legal Ethical and Social Aspects of Advertising; Process of Communication-Wilbur Schramm's Model, Two step Flow of Communication, Theory of Cognitive Dissonance and Clues for Advertising Strategies : Simulation of primary and Selective Demand-Objectives Setting and Market positioning; Dagmar Approach-Determination of Target Audience; Building of Advertising Programme Message. Headlines, Copy, Logo Illustration, Appeal, Layout; Campaign Planning; Media Planning, Budgeting Evaluation-Rationale of Testing Opinion and Aptitude Tests, Recognition Recalling Experimental design; Advertising Organization-Selection Comparison and Appraisal of an Agency, Electronic Media Buying Advertising campaign Advertising V/s Consumer Behaviour. Sales Promotion-Roe of Creative Strategies; Advertising-Retail, National, Cooperative, Political, International Public Service Advertising.

Suggested Readings

1. Aaker, David A. etc. Advertising Management, 4th ed. New Delhi, Prentice Hall of India. 1895.
2. Beleh, George E and Beleh, Michael A. Introduction to Advertising and Promotion. 3rd ed. Chicago, Irwin, 1998.
3. Borden William H. Advertising, New York, John Wiley, 1981.
4. Hard, Norman. The Practice of Advertising Oxford, Butterworth Heinemann, 1995.

5. Kleppner, Otto, Advertising Procedure. Englewood Cliffs, New Jersey, Prentice Hall, Inc., 1986.

6. Ogilvy, David, Ogilvy on Advertising. London Longman, 1983.

7. Sengaupta, Subroto. Brand Positioning, Strategies for Competitive Advantages. New Delhi, Tate Mc Graw Hill, 1990.

The list of cases and specific reference invading recent articles and reports will e announced in the pass at the time of launching of the course.

Master of Business Administration (M.B.A.)

MM-04 : RURAL MARKETING

OBJECTIVE

The objective of the course is to expose the students to the rural market environment and the emerging challenges in the globalization of the economics.

UNIT-I

Nature, characteristics an potential of rural markets in India. Socio-cultural, economic & other environmental factors affecting rural marketing. Attitudes and behaviour of the rural consumers and farmers.

UNIT-II

Marketing of consumer durables and non-durable goods and services in the rural markets with special reference to product planning, media planning, planning of distribution channels and organizing personal selling in rural markets in India. Marketing of agricultural inputs with special reference to fertilizers, seeds and tractors.

UNIT-III

Organization and functions of agricultural marketing in India. Classification of agricultural products with particular reference to seasonality and perishability. Marketing structure and performance. Processing facilities for different agricultural products.

UNIT-IV

Role of warehousing. Determination of agricultural prices and marketing margins. Role of agricultural price commission. Role of

central and state governments. Institutions and organizations in agricultural marketing.

UNIT-V

Unique features of commodity markets in India. Problems of agricultural marketing. Nature, scope and role of co-operative marketing in India.

Suggested Reading

1. Morleg, J.E. Agricultural Products and their marketing.
2. Kohles, Richerd L. : Marketing of Agricultural Products.
3. Boyle J.E. Marketing of Agricultural produce.
4. Taylor H.C. : Agricultural Economics.
5. Kulkarni K.R. Agricultural Marketing in India.
6. Mikherjee B.S. : Marketing of Agricultural Produce in India.
7. Gupta, A.P. “Marketing of Agricultural Products in India”.

SPECIALIZATION-II (Three Courses)

(Courses 307 to 309)

Master of Business Administration (M.B.A.)

HRM-01 : INDUSTRIAL RELATIONS

UNIT-I : INDUSTRIAL RELATIONS

Meaning and significance of Industrial Relations. Introduction, the concept of Industrial Relations, Factors determining the Industrial Relations. Essentials of I.R., Significance of I.R. IRs and Growth of Industrial Relations. I.R. and Human Relations approaches to Human Relations.

UNIT-II : TRADE UNUIONSIM

Definition of Trade Union, Labour Movement and the Trade Unions, needs for Trade Unions, Rise and Growth of Trade Unionism. Objective of Trade and Economic Development, trade Unions and Wages, Essentials of Strong and Successful Trade Unions. Trade Union Movement in India and other countries USA, Germany, England and Russia.

Principal defects in Trade Union Movement in India measure to strengthening the Trade Unionism in India.

UNIT-III : INDUSTIRAL DISPUTES, PREVENTION AND SETTLEMENT OF I.D. I DELHI

Meaning of Industrial Disputes, Causes of Industrial Disputes, Impact of Industrial disputes on Production and economic Development of the country. Forms of Industrial disputes, Strikes, Gherao, lockouts and other forms . Methods for the prevention of Industrial Disputes. Labour Co-partnership. Objects, important methods for the settlement of Industrial Disputes-Investigation, Voluntary arrangements for conciliation and arbitration, compulsory conciliation and arbitration. Prevention and settlement of Industrial disputes, Legislative and other measures I.D. in India after

independence. Existing methods of settlements and Prevention of I.D. in India, Conclusion.

UNIT-IV

Introduction-Functions of Collective bargaining, conditions for the success of collective bargaining, growth of collective bargaining management. Approaches to collective bargaining collective agreement in India. Trade Unions approach to collective bargaining.

UNIT-V

Objective of Workers participation, methods of workers participation, Essentials of workers participating in management. Functions of Join Management Council, Progress and working of JMC in India. Future prospectus of J.M.C. Forms of participative management. Concept of Labour Welfare, Labour Welfare in India, I.L.O. and India.

BOOKS RECOMMENDED		
1.	Mathus A.S.	Labour Policy and Industrial Relations in India.
2.	Dr. Bhagaliwal T.N.	Economics and Labour and Social Welfare.
3.	Butler A.D.	Labour Economics and Institutions
4.	Mehrotra S.N.	Labour Problems in India.
5.	Punckar S.A.	Industrial Peace in India.
6.	Singh V.B.	Industrial Labour in India.
7.	Lester I.A.	Economics of Labour.
8.	Mecheal V.P.	Industrial Relations and Workers Involvement in Management in India.

Master of Business Administration (M.B.A.)

HRM-02 : ADVANCED INDUSTRIAL PSYCHOLOGY

This course has been designed to provide certain deep insights into certain concepts of Industrial Psychology At east one question from each part is to be attempted by the student in the examination.

Unit-I

Introduction-Industrial Psychology concept, Development of Industrial Psychology, Scope of Industrial Psychology Major Problems of Industrial Psychology. Psychological Tests : Characteristics of Psychological Tests, Types of Tests, Importance and Limit in of Psychological Tests.

Unit-II

Attitude and Human Engineering : Meaning, Components of attitudes, attitudes measurement and change, cognitive dissonance theory; measurement the A-B relationship. Human Engineering—work study, time study, motion study, job enlargement, job enrichment. Total Quality Management. Total Quality People.

Unit-III

Learning & Development-Definition, theories; classical conditioning operant conditioning, conditions of learning development process.

Unit-IV

Personality and Interpersonal Relationship-Meaning, theories of personality. Interpersonal Relationships and group dynamics. Determinants of interpersonal relationships, management of interpersonal relationships, group dynamics formal, informal groups, group decision-making, group think & group shift.

Unit-V

Fatigue, Monotomy, Bordom Safety, Accidents, Organizational stress major cause, major effects and coping with stress, work and equipment design, working conditions.

Readings

1. M.L. Blum and J.C. Naylor, Industrial Psychology, 1984, GBS publishers, Delhi.
2. E.J. Mc Cormic and Ilgen, Industrial Psychology 1984-PHI New Delhi.
3. Drench, Thierry, Williams and Wolf : handbook of Work an organizational Psychology, Vol. I and II 1984.
4. Robert C. Beck, Applying Psychology, understanding people; PHI, 1982.
5. Major, Psychology in Industry, Oxford &IBH.
6. Edger Scheme Organisational psychology, PHI, New Delhi.

Master of Business Administration (M.B.A.)

HRM-05 : HUMAN RESOURCES DEVELOPMENT

Unit-I

Human Resources Development : Meaning, need importance HRD, Mechanism, Processes. Instruments & out-comes. Principles & Theories of learning. Human Resource Development Strategies & Practices.

Unit-II

HRD & the Supervisor : The HRD Matrix, role of line managers in HRD, Line Mangers and Appraisal Systems, Career Systems, training systems, work systems, cultural systems and self-renewal system.

Unit-III

Career Planning : Organization vs. Individual centered career Planning, Changing careers, Career Stages, Retirement, Effective Individual career Planning, Career Path Development, Dual Career Marriages.

Unit-IV

Counselling and Monitoring : Concept, Objectives and Processes, Listening and Asking, Nursing and helping.

Unit-V

HRD Culture & Climate : concept, HRD and Organizational Climate, Elements and Measurement of HRD Climate, Determinant of HRD Climate.

References		
1.	Arye P.P. & B.B. Tandon	Human Resources Development
2.	David A. DeCenze & S.P. Robbins	Personnel/Human Resource Management
3.	Randall S. Schular	Personnel & Human Resource Management
4.	Robvert B. Mathis & J. H. Jackson	Personnel & Human Resource Management
5.	Leon C. Meggin Sen	Personnel & Human Resource Management
6.	Edwin B. Flippo	Personnel Management
7.	Josepth Tiffen and Mc Cormic Earnest J.	Industrial Psychology
8.	Richard P. Chlheen	Managing Personnel

UNIT I

LESSON NO. 1

MIS: CONCEPT EMERGENCE & ROLE, COMPUTERS & MIS

There have been turning points in the evolution of mankind. For example, invention of potter's wheel, discovery of fire etc. These turning points, often called as strategic inflection points, drastically changed the manner in which people lived and conducted their daily business. One such strategic inflection point at the dawn of the twenty-first century is the growth of information technology. In today's world, no aspect of life has remained untouched from its impact and marketing is no exception. Information is as vital to an organisation as is blood to human body. In the competitive world of today, only those firms are successful which have access to accurate and timely information and means to draw meaningful conclusions from the same. Mere possession of information is not sufficient. An organisation must have a complete system to process it and assimilate it in the overall system of the organization.

Concept of information system

Before developing the concept of information system, it is desirable to define some of the related concepts. (Source: O'Brien)

1. *Data*:

Data is defined as the representation of facts, concepts or instructions in a formalized manner, suitable for communication, interpretation or processing by a human being or an electronic machine. It can be both qualitative and quantitative. The quantitative data can be expressed in the form of measurable connotations or symbols, while the qualitative data can be expressed in descriptive form. For example, sales, exports, growth rate, profits of an organisation are some of the facts that are represented in the numerical terms.

2. *Information*:

Information is the organized or classified data, from which certain conclusions can be drawn. For example, the fact that the sales of a company are 20% higher over the sales of the last year provides an idea of its functioning in the last financial year. This has been derived from the sales figures of last year and the current year. The sales figures do not convey much on their own, but the growth of company does convey something about its performance. So, the sales figures can be called as data and the growth rate as the information derived from it.

3. *Information System*:

It is a set of people, procedures and resources that collects, transforms and disseminates information in an organisation. In other words, an information system is a system that accepts data resources as inputs and processes them into information products as outputs.

4. *Management Information System*:

This is a management support system that produces pre-specified reports, displays and responses on a periodic, exception, or demand basis.

5. *Marketing Information Systems*:

They are the systems that support the planning, control and transaction processing required for the accomplishment of marketing activities such as sales management, advertising and promotion. According to Kotler, marketing information system consists of people, equipment and procedures to gather, sort, analyze, evaluate and distribute the needed, timely, and accurate information to marketing decision makers.

2. Evolution of information systems

Until 1960s, the role of information system was confined to transaction processing, record keeping, accounting, and other electronic data processing (EDP) applications. During this time, the concept of management information systems (MIS) evolved. This new

role of information systems focused on providing managerial end users with predefined management reports that would give the managers, the information they needed for decision-making purposes. The management information systems transformed into decision support systems (DSS) in the 1970s because the pre-specified information products produced by MIS did not meet the requirements of the managers. DSS provided managerial end users with ad hoc and interactive support of their decision-making processes. This support could be tailored to the unique decision making styles of managers as they faced the specific problems.

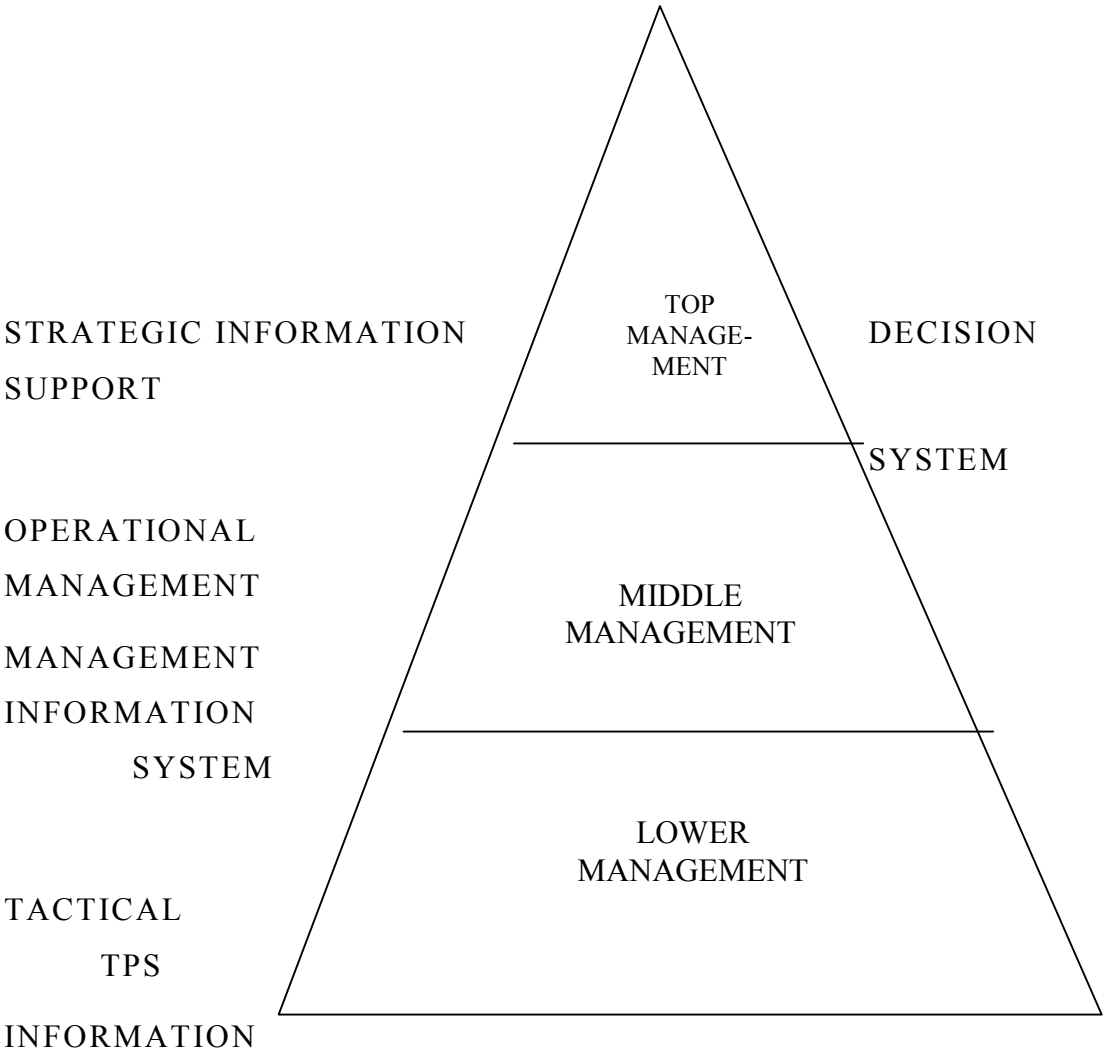


Figure 1: Levels of management and information systems

In 1980s, several new roles of information systems appeared. This period saw the fast growth of personal computers and thus the phenomenon of end user computing. The managers could collect and process information as per their requirements themselves and did not have to depend on the specialists of computer software. The software packages became more user friendly. Earlier, managers did not make use of computerized information because they could not operate them on their own. This period also saw the emergence of the concept of executive information systems (EIS).

Business information systems also witnessed the application and use of artificial intelligence (AI) and thus the expert systems and other knowledge-based systems evolved. The 1990s have witnessed phenomenal transformation of the manner in which the managers collect and process information. MIS has acquired the role of strategic information systems (SIS). Also, networking of several computer systems and the evolution of Internet has a tremendous effect on the information systems.

It may be observed that over the years, there has been a change in the nature of information systems. Starting from a transactional processing system, they have transformed to decision support systems and management information systems. This has facilitated the use of computerized data processing for use by all the levels of management of an organisation, as shown in figure 1.

The above figure shows that the requirement of information varies with the level of management. At the lower level of the management, the information required in called tactical information. The tactical information is routine in nature and is required for day to day functioning. This information is processed with the help of transaction processing system. This system is concerned with carrying

out relatively simple, but repetitive computations on a large number of records involved, such as payroll preparation, inventory records, sales accounting etc.

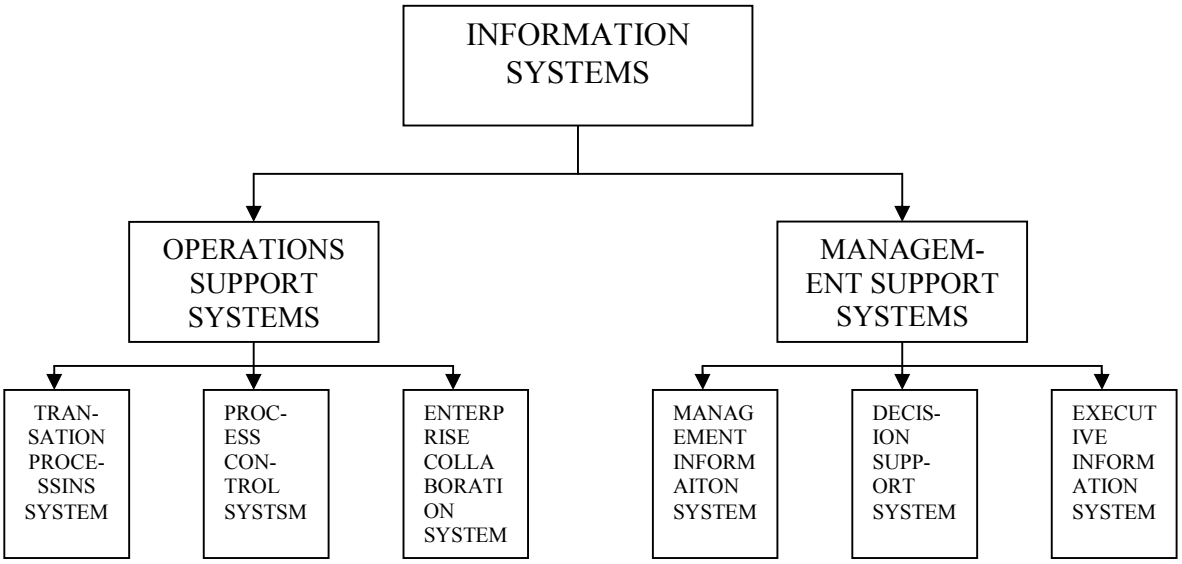
At the middle level, the managers are concerned with the information that helps them in medium term planning. They do not require the information on day-to-day working as the same is taken care of by the lower management. They need information on some critical areas that help in setting the objectives that meet the targets set by the top management. This operational information is processed with the help of management information system.

The managers at the top level require the strategic information, which is used for setting objectives and formulating long-term corporate strategies. Top management requires accurate and vital information of only some key areas. Generally, the top management does not require any routine information on day-to-day activities. The vital, selective, strategic information can be analyzed through decision support systems. It must be noted that this distinction of information system types is not very strict as no clear boundaries can be drawn between them, particularly between MIS and DSS. With time, newer packages are being launched into the market and they have different features. Their vendors often coin newer terminologies for them.

3. Types of information systems

The information systems can be classified on several bases. On the basis of the role they play in the operations and management of a business, the classification of information systems is shown in Figure 2. The information systems are of two types- operations support systems and management support systems. Further, operations support systems comprise of transaction processing systems, process control systems and enterprise collaboration systems. The management support systems comprise of management information systems, decision support systems and executive information systems.

Figure 2:Classification of information systems (Source O'Brien pp 56)



3.1 **Operations Support Systems:**

They produce a variety of information products for internal and external use. However, they do not produce specific products for use by managers and the data generated by them has to be processed further to draw meaningful conclusions. Still, they play a vital role in the efficient processing of business information, control of business processes and updating of corporate data bases. The operations support systems comprise of the following:

i) Transaction Processing Systems (TPS)

TPS record and process the data resulting from business, e.g information systems that process sales, purchases and inventory changes etc. The results of these databases are used to update customer, inventory and other databases and serve as resources for other information systems such as management information systems, decision support systems etc. TPS can be batch processing systems as well as real-time (or online) processing systems.

ii) Process Control Systems

The routine decisions have to be made in an enterprise to control the business processes and run day to day affairs. This is done with the help of process control systems. For example, managers need data on inventory in order to reorder the same automatically. The process control systems are also used to control the production processes in case of large plants run on automatic machines.

iii) *Enterprise Collaboration Systems*

These information systems use a variety of information technologies that help the people to work together. They help to collaborate, communicate, share resources and achieve coordination in an enterprise, both formal and informal.

3.2 **Management Support Systems**

They are the information systems that focus on providing information and support for effective decision making by the managers. The concept of MIS originated in 1960 and has been used very frequently since then. It is the managerial application of information technology and is not confined only to the technical aspects of computer hardware and software. It emphasizes that the systems frame work should be used for organizing information system. This is important because of the interrelatedness of business information.

i) Management information systems

MIS are the most common form of management support system. They provide the managerial end users with the information products that support much of their day to day decision making needs. They provide a variety of reports for use by the management.

ii) Decision support systems

They are a natural progression from information reporting systems and transaction processing systems. They are interactive, computer based information systems that use decision models and specialized databases to assist the managerial decision makers. While TPS focus on the processing of data generated by business transactions and operations, DSS extract data from corporate databases maintained by TPS. Similarly, they differ from MIS, which focus on providing the managers with pre-specified information reports that can be used to help them to make more effective and structured decisions. DDS provides the managerial end users with the information on an interactive and adhoc (need-based) basis.

iii) Executive information systems

They are the management information systems tailored to meet the needs of strategic information of the top management. The top executives get the information from the sources such as reports, letters, memos, periodicals etc. The goal of EIS is to provide the top management with immediate and easy excess to selective information on key factors that are critical to accomplishing the firm's strategic objectives.

4. Cross functional information systems

While each department of a firm is complete in itself and acts as a system, there exists a lot of interdependence between them. Because of the interdependence, they need to share the information. For this purpose many organizations use information technology in order to develop cross functional business information systems. The following figure shows various business

information systems and the manner in which they support major functional areas of business.

The packages such as ERP (enterprise resource planning) etc. have developed cross functional information systems to meet the varying requirements of firms. The present lesson is confined only to marketing information systems

The concept of management information systems in the context of business functions can be described with the help of an example of marketing information systems, as contained in the following discussion.

5. Marketing information system

Marketing is one of the most important activities of a firm. While there are many ways to look at the marketing function, it is primarily concerned with the planning promotion and sale of products. Marketing information systems employ information technologies that support major components of the marketing functions. As shown in figure 4, MIS comprises of interactive marketing, sales

automation, advertising and promotion and sales management. It also includes marketing research and forecasting, customer service and support and product management.

a) *Interactive marketing*

The term interactive marketing describes the marketing based on internet, intranets and extranets to establish a two way interaction between the customers and the firm. Interactive marketing enables a company to profitably use those networks to attract and keep customers who will become partners with the business in creating, purchasing and improving products and services. The interactive marketing enables the firms view the customers as belonging to the distinct segments and meet their specific requirements. This

targeted marketing technique enables them to service their customers better and thus derive s long-term profitability.

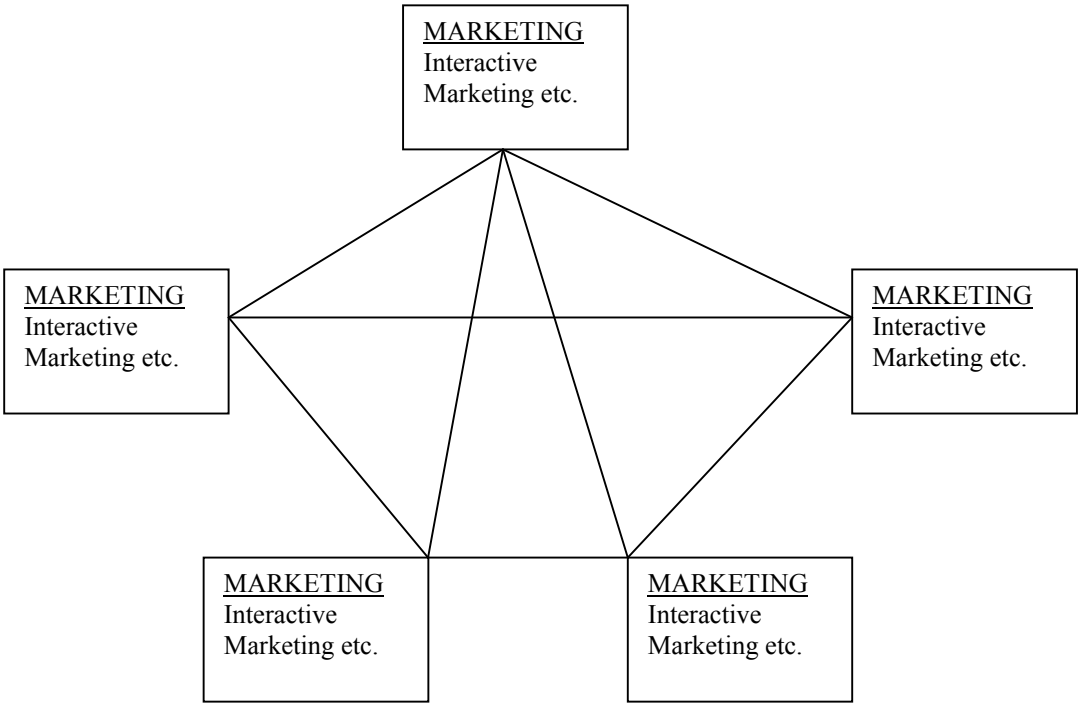


Figure 3: Cross-functional information systems

b) *Sales force automation*

Many companies are finding novel ways to automate the collection and processing of the information generated by the sales force. Many companies have established intranets that keep the sales force in touch with the top managers at all times. This not only increases the productivity of the sales force, but also speeds up their operations in the market-place. They can offer the products to the customers faster and keep their customers satisfied and delighted.

c) *Sales and product management*

Sales management entails continuous support to the sales team and also monitoring of their performance. Computer based systems enable fast sales analysis by product and territory. These reports

can improve the performance of the sales teams drastically. Similarly, product managers require continuous information to plan and control the performance of specific products and product lines. IT enabled information systems have speeded up the decision making based the information gathered from the market place.

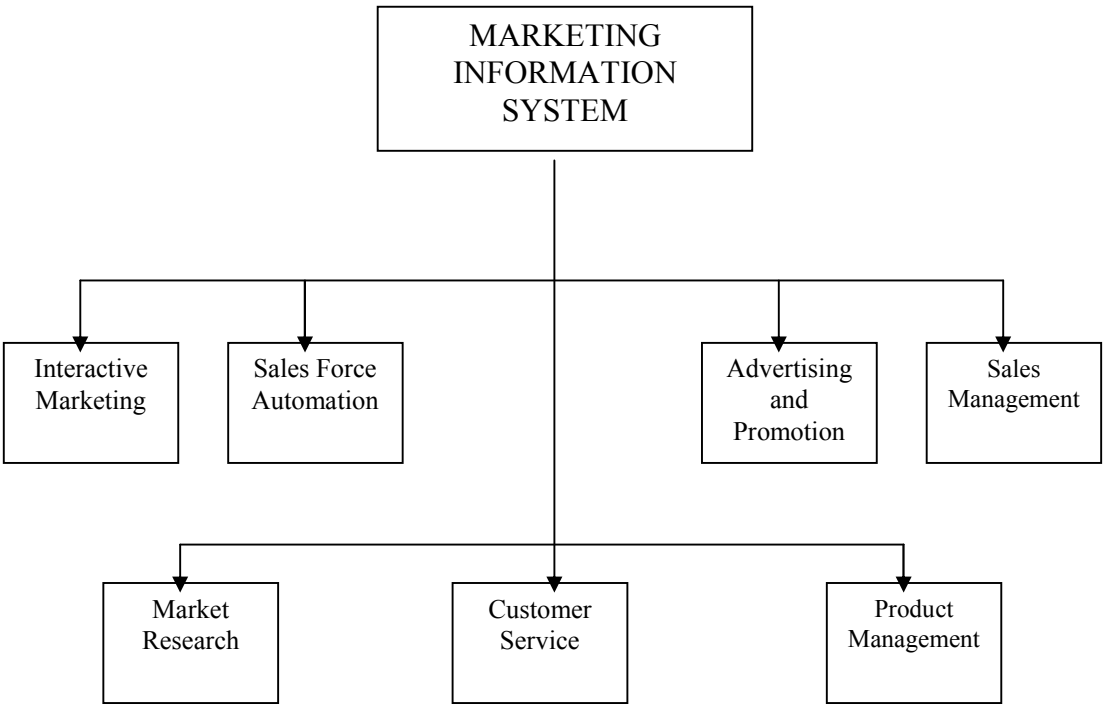


Figure 4: Marketing Information System

d) *Advertising and Promotion*

Marketing information systems use marketing research information and promotion models for the selection of media and promotional methods, allocation of financial resources, control and evaluation of results of various advertising and promotion campaigns.

e) *Targeted marketing*

Targeted marketing entails designing the marketing mix in order to specifically meet the requirements of a target market. For example,

a firm can identify unique characteristics of a market and design its product offering, especially tailored to meet the requirements of that segment. This is possible only when the marketers have the knowledge about the target markets, possible through IT enabled systems.

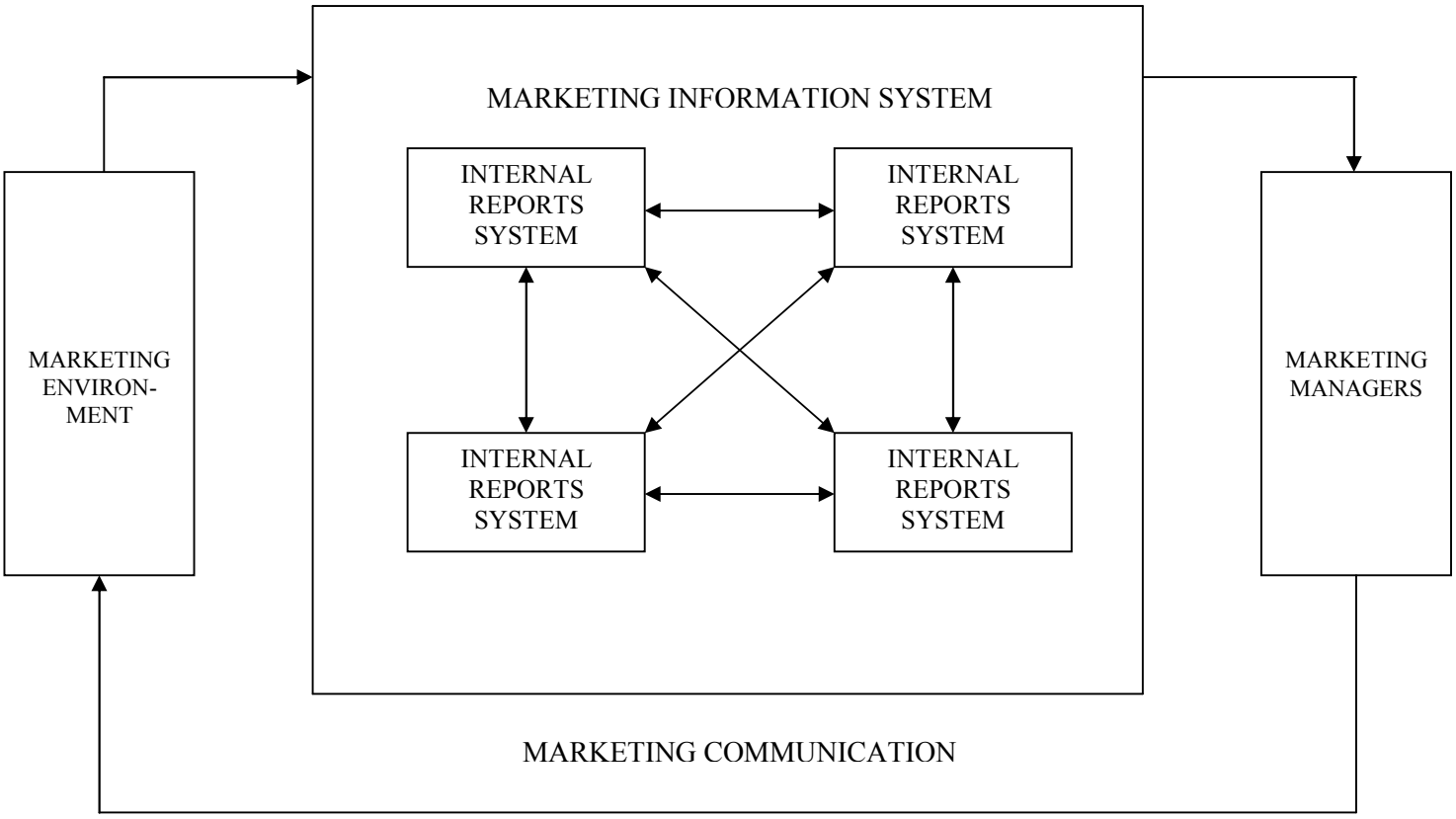


Figure 5: Components of marketing information system

f) *Marketing Research and Forecasting*

IT enabled information systems have revolutionized the marketing research in firms. They can collect the data more easily that before. Also, they can analyze the same and formulate strategies to meet the newer challenges in the market place. The difference between MIS and marketing research is quite thin and each provide inputs to the other. A firm needs both in orders to be successful.

6. Components Of Marketing Information System:

The marketing information system concept is illustrated in Figure 5.

The box on the left shows the components of the marketing environment that marketing managers must monitor. Trends in the marketing environment are picked up and analyzed through four subsystems that make up the marketing information system-*the internal reports system, marketing intelligence system, marketing research system and analytical marketing system.* The information flows to marketing managers in order to help them in their marketing analysis, planning, implementation and control. Their marketing decisions and communications then flow back to the market. Each of the four components of MIS are explained herein:

1. Internal Reports System

This includes basic information system used by marketing executives is the internal reports system reports on orders, sales, inventory levels, receivables, payables and so on. By analyzing this information, marketing managers can spot important opportunities and problems.

(i) The Order-Shipping-Billing Cycle

The basic internal reports system is the order-shipping-billing cycle. Sales representatives, dealers and customers place orders to the firm. The Sales department prepares multi-copy invoices and dispatch orders and sends them to various departments. Out-of-stock items are back ordered. Shipped items are accompanied by the multiple copies of shipping and billing documents, sent to various departments. The company needs to perform these steps quickly and accurately. The sales representatives are expected to send in their orders everyday or even immediately. The order-shipping cycle is not confined to the marketing department only. The information on finished stocks and orders in hand has to be sent to the production department so that it can plan its production schedule. The information has to be sent to purchase department so that it can replenish the inventory of raw

material and consumables in time. This helps in continuous production and avoids any shut down due to lack of raw material. The finance department also needs this information because it has to plan the flow of funds based on the cash inflows and outflows. Thus, the inter-relatedness of various functional units of a firm is strengthened and the firm can produce a better output as a system. The order department is designed to process them quickly. The warehouse is set up to send the goods out as soon as possible. And bills should go out as soon as possible. The computer is harnessed to expedite the order-shipping-billing cycle. Computerized systems enable them to email the orders o the warehouses immediately.

(ii) Improving the Timeliness of Sales Reports

Marketing executives receive sales reports some time after the sales have taken place. In consumer-food companies, warehouse withdrawal reports are issued with fair regularity, but actual retail purchase reports take about two months, based on special store or consumer panel audits. In the auto industry, executives wait about ten days for their sales report. If the sales are down, they will have to work harder and face ten sleepless nights until the next report. Many marketing executives complain that sales are not reported fast enough in their company. Inspite of IT tools, there can be delays in flow and retrieval of sales information.

(iii) Designing a User-oriented Reports System

While designing an advanced sales-information system, the company should avoid certain pitfalls. Firstly, it may create a system that delivers too much information. The managers may have to face voluminous sales statistics, which they either ignore or spend too much time on. Secondly, it is possible to create a system that delivers information that is too current. Managers may end up overreacting to minor sales reversals. The company's marketing

information system should represent a balance between what managers think they need, what managers really need and what is economically feasible. These pitfalls lead to inefficiency in the information systems. Excess of information is not desirable as it confuses the users and they might be entangled in it. The information should be only of certain critical indicators and not include every bit of minor details. Similarly, information should be timely so that the managers do not overreact or ignore the same. One of the drawbacks of the current IT packages is that they produce excess of information, that is too current. Managers need to comprehend them with caution in order to attain an optimal sales response. A useful step is the appointment of an *internal marketing information systems committee,* which interviews a cross section marketing executives-product managers, sales managers, sales representatives and so on to discover their information needs.

(iv) Marketing Intelligence System

While the internal reports system supplies managers with *results data* the marketing intelligence system supplies managers with *happenings data.* Kotler defines the *marketing intelligence system as the set of producers and sources used by executives to obtain their everyday information about pertinent developments in the marketing environment.*

The marketing executives of a firm scan the environment in four ways:

a) *Undirected viewing***.** General exposure to information where the manager has no specific purpose in mind.

b) *Conditioned viewing***.** Directed exposure not involving active search to a more or less clearly identified area or type of information.

c) *Informal search***.** A relatively limited and unstructured effort to obtain specific information or information for specific purpose.

d) *Formal search.* A deliberate effort usually following a pre-established plan, procedure or methodology to secure specific information or information relating to a specific issue.

Marketing executives carry on marketing intelligence mostly on their own by reading books, newspapers and trade publications, surfing Internet, talking to customers, suppliers, distributors, and other outsiders and talking with other managers and personnel within the company. Yet this system is quite casual and valuable information may be lost or arrive too late. Executives may learn of a competitive move a new-customer need, or a dealer problem too late to make the best response. In order to avoid falling in this trap, they need to design a marketing intelligence system to get timely information of the markets.

Well-run companies take additional steps to improve the quality and quantity of marketing intelligence. First, they train and motivate the sales force to spot and report new developments. Sales representatives are the company's "eyes and ears". They are in an excellent position to pick up information missed by other means. Some companies, such as Cipla Ltd., even device out incentives for the sales team to motivate them to provide timely information of the market. The sales team keeps a track of the bonus offer schemes, price cuts and other moves of the competitors.

Second, the company motivates its distributors, retailers, and other middlemen to pass along important intelligence. The marketing channels are a powerful source of information. Any happening of market-place is known to the wholesalers and retailers. Firms having a good rapport with them get timely information from them. However, the problem can crop up if the wholesalers and retailers are serving competitor firms also. In such cases, there is a danger of the firm's information passing into the hands of the competitors. Despite this limitation, marketing channels can be judiciously employed as conduits of relevant market information.

Third, the company can purchase information from the suppliers. The suppliers have business interests with a firm and they also with that its sales grow. The growth of a firm's sales leads to the growth of their suppliers' sales also. So, the suppliers can cater to the information needs of a firm in the form of competitor's reports, sales literature, circulars, advertisements etc. Even secret information on the purchase price of the competitors can be accessed from the suppliers. However, suppliers serving the competitors also leak the firm's information.

Fourth, some companies have established an internal *marketing information center* to collect and circulate marketing intelligence. The staff scans major publications, abstracts relevant news, and disseminates a news bulletin to marketing managers. It collects and files relevant information. The staff assists managers in evaluating new information. These services greatly improve the quality of information available to marketing managers. Firms can even employ tactics such as purchasing a competitor's product, participating in their shareholders' meetings etc. This can give them vital information about the competitors.

2. Marketing Research System

Besides the information generated from the internal reports and marketing intelligence, the marketing executives often need focused studies of specific problems and opportunities. They may need a market survey, a product-preference test, a sales forecast by region, or an advertising-effectiveness study. The managers themselves normally do not have the skill or time to obtain this information. They need to commission formal marketing research. *Marketing Research may be defined as a systematic design, collection, analysis, and reporting of data and findings relevant to a specific marketing situation facing the company.*

Marketing research can be obtained by firms in a number of ways. Most of the large firms have their in-house marketing research

departments. Firms that cannot afford to have a marketing research department can make use of marketing research companies and consultants. They can also engage MBA students and Universities to conduct marketing research for them. Nowdays, a lot of information is being taken from the Internet. Depending upon their requirements, they can hire syndicated service research firms, custom marketing research firms and specialty line marketing research firms.

Basically, marketing research process, comprises of the following steps:

a) Define the problem.

b) Develop the research plan.

c) Collect the information.

d) Analyze the information.

e) Present the findings.

A further discussion on the process of marketing research is beyond the scope of this lesson and is covered in other lessons.

3. Analytical Marketing System

Many companies have started using a fourth information service to help their marketing executives an analytical marketing system. Today's marketing managers in companies can use their computer terminals and answer many questions based on stored data that were formerly inaccessible. Their computers store a bank of linked statistical and decision models that make up a *marketing decision support system.*

A marketing decision support system is a coordinated collection of data, systems, tools and techniques with supporting software and hardware by which an organization gathers and interprets relevant information from business environment and turns it into a basis for marketing action. Some of the statistical tools used in marketing are

multiple-regression, discriminate analysis, factor analysis, cluster analysis, conjoint analysis, multidimensional scaling etc. Commonly used marketing models are Markov-Process model, queuing model, new-product pretest models, sales response models etc. Several computer software such as SPSS (Statistical Package for Social Sciences), STATISTICA, Marketing Engineering packages etc. are available in the market. They can be employed to analyze the information in a very convenient way. It needs to be cautioned that these are tools for analyzing information. The information has to be provided to them by collecting it from the right source and in the correct manner.

Limitations of marketing information system

Information in itself is a very deceptive tool and needs to be used with caution. It can lead to erroneous results, if it is not interpreted correctly. So, the limitation of any information system stems from the manner in which information is collected and interpreted. Mostly, managers lack a clear understanding of what they want from any system. They might collect the information that is not required. Managers also face the problem of excessive information, most of which might not be relevant. The information collected must be specific, succinct and relevant. It is also essential that MIS should supplement the overall management information system of a company. If there is a mismatch between the two, there can be lack of understanding between various departments of the company and can create confusion and conflicts. This can create more problems for the management, instead of solving them.

Information is the key element to the success of an organization. This is a vital ingredient to make an organization perform its operational and strategic functions. The information requirement of the management varies at different levels and so do the systems and processes that generate and process the information. The effective information system provides the reliable, timely and accurate

information to the right person in the right form. Since the flow of information is inter-related, the systems perspective must be followed to ensure smooth flow of the information across the functional areas in an organization.

Self Assessment Questions:

Q.1. What is management information system? Why is it desirable to have a management information system?

Q.2. What are various types of management information systems? Briefly discuss their evolution and growth.

Q.3. Differentiate between data and information.

Q.4. What are various types of marketing information system? What are various components of a marketing information system?

Suggested Reading

1. James A. O'Brien (2000) Management Information System, Tata McGraw Hill Edition.
2. Jack D. Callon (1996) Competitive advantage through information technology, McGraw Hill
3. Charles Parker (1998) Management Information Systems, McGraw Hill, 2nd Edition.
4. Vladimir Zwass (1998) Foundations of information systems, McGraw Hill
5. Robert Schultheis and Mary Summer (1998) Management Information Systems, McGraw Hill, 4th Edition.

UNIT II

LESSON 2

DECISION MAKING AND OPERATION RESEARCH

Decision making lies deeply embedded in the management process and is the only vehicle for carrying managerial workload. Decision making permeates through all managerial functions and covers every area of the enterprise. Decision making is the sole way in which managers can discharge their functions of managing. Management, as a specialized activity, can be carried on only in the form of decision. The task of decision making is the distinguishing mark that identifies a person as the manager of any undertaking. Management and decision making are bound up inseparably, and they go hand in hand.

Whatever a manager does he can do it by taking some decision from a number of alternative courses of action. Whether a manager orders or advises, plans or organizes, approves or disapproves a work, hires or fires an employee, he is engrossed in the process of decision making. An uninformed manager who manages his job traditionally may not be aware that he is making decision constantly. But a little reflection will reveal that he cannot move even a step in his managerial work without decisions. In other words, the management process consists of a bundle of decisions in all areas and for all activities of the enterprise. All matters relating to planning, organization, direction and control are settled by managers through decisions, which are executed into practice by operators of the enterprise.

Deciding and planning.

Deciding is no doubt a form of planning, deciding affects in most cases a future course of action and involves choosing among alternatives. For that matter, deciding and planning have cognate meanings. Planning as a whole with its component parts like objectives, policies and procedures is the outcome of decision making. Furthermore, as planning is necessary for other managerial functions of organizing, directing and controlling, decision making too has a pervasive influence on all managerial functions. Because of this situation, decision making is regarded by many writers as a part of the planning process. But many and varied operating orders and instructions are given by the middle and supervisory managers for getting the work accomplished through people. Such ordering and instructing involve decision making within the framework of planning. Should the task of order giving or instruction giving be included within the planning function of management? If included, there does not exist any distinction between planning and directing functions of management. Again, in firing employees, in motivating them or in disapproving their work, decisions are taken by all managers. If such decision making is regarded as a synonym of planning, we cannot make an analytical study of the complex management process.

Types of Decisions :

Decisions are broadly divided into two categories; the first includes the typical, routine or unimportant decisions and the second is made up of important, vital or strategic decisions. Routine decisions involve no extra-ordinary judgment, analysis and authority, since they are to traverse along more or less fixed avenues. Ends of the enterprise are clearly established and the definite means to secure the ends are also given. Within the given means and ends, routine decisions demand a power of selection of the shortest path,

as the connecting link between means and ends, on the part of managers. On the other hand, strategic decisions aim at determining or changing the means and ends of the enterprise. They require a thorough study, analysis and reflective thinking on the part of managers. Strategic decisions are usually taken by top managers, while routine decisions are made mostly by lower-level managers.

Decisions are also classified from other approaches with a view to revealing their routine or strategic nature. First, from the stand-point of futurity of the decision, decisions may be deemed either as routine or as strategic ones. For more distant future the risk and uncertainty involved in decisions increase proportionately. Decisions nature are to be carefully thought through and analysed before they are made effective, since they commit the enterprise to enter in to speculation about the uncertain future and introduce important changes in its affairs. But the risk element is reduced in decisions requiring the solution of current problems or problems of the near further and such decisions are taken within defined jurisdiction. Where the degree of risk and uncertainty is high, decisions are reserved for top-level managers; otherwise they are pushed down to the lower level of management.

Secondly, according to the frequency or rarity of some decisions, they may be looked upon as routine or strategic decisions. The routine decisions are often repeated so as to reduce their uncertainty and risk to a minimum, and they are usually taken against a familiar background. Particularly, when such decisions are taken within the framework of established policies and procedures, they become so routine in character that such decisions can be taken by managers of the lower level. But in the case of rare decisions not covered by established policies and procedures, the managers are required to probe the matters to the bottom to find out any hidden difficulty, to utilize any untapped resource, or to unlock any

revealing situation. The rare decisions, in most cases, require a searching analysis on the part of top managers.

Thirdly, from the approach of their impact, decisions may affect one department, several departments or the enterprise as a whole. Decisions, to be made effective, must be supported by necessary authority. A departmental manager cannot take a decision affecting other departments, areas or functions of the enterprise. It is a truism to state that managers must decide matters falling within their jurisdictions. Enterprise decisions are taken at the highest level, inter-departmental decisions are made by the superior manager in collaboration with managers of the affected departments, and departmental decisions by managers of their respective departments. This order of arrangement is followed in the case of routine decisions. But strategic decisions, wherever they may arise, cannot be made in this fashion. Even a departmental decision may be raised to the status of strategic one because of the elements of either rarity or futurity of decisions.

Fourthly, some decisions require judgment of non-economic factors like ethical values, moral conduct or human behaviour in the enterprise. The presence of these quality considerations in decision making calls for a judicial function that can only be discharged by managers of the higher level. To ensure unbiased decisions on these qualitative and intangible problems, decisions of this nature are pushed up to the top of the organization. Many questions of human relations are not decided by the personnel department head, but they are taken up by superior managers. Human problems that are fully covered by established policies and procedures are, however, decided at a lower level.

Finally, decisions can also be classified into programmed and unprogrammed decisions. Programmed decisions are standing decisions in repetitive situations, and they include objectives,

policies, procedures, standards and rules. Unprogrammed decisions are special-purpose decisions that require creativity and a greater amount of judgment and they include programmes, budgets and strategies. Programmed decisions can be easily delegated to lower levels of the organization. But unprogrammed decisions require the attention of superiors.

Process of Decision Making

The decision-making task can be divided into six steps which are stated in order of their sequence as follows :

1. **Making the diagnosis:** The first step is to determine what the real and correct problem is. If the problem is not ascertained correctly at the beginning, money and effort expended for the decision over a wrong problem are sure to go in waste. Furthermore, the original situation will not be brought under control; rather new problems will stem from this incorrect appraisal of the situation. In other words, the presence of one or two visible symptoms of a disease should not tempt a manager to arrive at the correct diagnosis. Symptomatic diagnosis often betrays the real issue, and it should be replaced by analytical methods as far as practicable. In short, it is to be realized that a problem is half solved when it is well defined, and it is foolhardy to search for a correct solution of an incorrect problem.

2. **Analysing the problem**: The problem should be thoroughly analysed to find out adequate background information and data relating to the situation. This analysis may provide the manager with revealing circumstances that help him to gain an insight into the problem. The whole approach to the problem should, however, be based around the limiting or critical factors. There can be innumerable factors involved in any situation, some of which are pertinent and others are remote. To minimize the expense of time and effort, the analysis is required to be directed towards

pertinent and closely connected factors, as dictated by the principle of the limiting or strategic factor. Of the mass of data and information collected, facts should be screened out and separated from beliefs, opinions or preconceived notions. The focusing of attention on crucial factors helps the manager to spell out facts of the case. And as a basis, facts alone provide the solid foundation for making decisions.

3. **Searching alternative solutions**: The analysis of the problem can never become thorough and satisfactory unless attempts are made to search for several alternatives. There is hardly any course of action wherein alternatives cannot be developed. The search for alternatives forces the manager to see things from many viewpoints, to study cases from their proper perspectives, and to unearth troubled spots of the problem. In the absence of alternatives, the decision-making process becomes a mechanical job. Routine decisions of this type may not give rise to any serious difficulty. But strategic decisions can never be taken in this fashion, because they will complicate the problem rather than easing it. In other words, the practice of developing alternatives is the best guarantee for ensuring adequate attention on the part of managers. It also avoids bottlenecks to operation consequent upon the failure of one decision in the enterprise, since alternative decisions can be put into effect without delay.

4. **Selecting the best solution** : The selection of one best course of action, out of several alternatives developed, requires an ability to draw distinctions between tangible and intangible factors as well as between facts and guesses. Sound knowledge and accumulated experience provide some managers with an uncanny ability to choose the best course at a greater ease. Practical experience counts much in this step of decision making. In any case, the evaluation of several alternatives is made from a consideration of their probable results on enterprise objectives.

Four criteria have been suggested by Drucker in selecting the best solution : (a) the proportion of risk to the expected gain, (b) the correspondence between economy of effort and possibility of results, (c) the timing considerations that meet the needs of the situation, and (d) the limitation of resources.

5. **Putting the decision into effect:** Even the best decision may become inoperative due to the opposition of employees. The decision can only be made effective through the action of other people. Overcome the opposition or resistance on the part of employees, managers must make necessary preparations for putting the decision into effect. There are three important things relating to this preparation, viz., communication of decisions, securing employee acceptance and the timing of decisions. Any change involved in the decision should be made known to all employees in clear, precise and simple language. Opportunity must be given beforehand to know and understand the expected changes. After communication, the necessity of changes should be explained to win over their co-operation. In many enterprises, the selection of the best course of action is made through group decisions with the primary object of securing whole-hearted participation from the side of subordinates. As all decisions affect the employees and their work, they must be taken into confidence for securing their willing support. Otherwise, the best of decisions sabotaged in such a manner as to elude the attention and efforts of most managers. Opportunity time is to be determined and favourable circumstances are to be created for converting a decision action. Moreover, some human relation's factors are usually taken into consideration for determining whether the entire decision is to be put into action at one time, or it is to be introduced piecemeal. Timing considerations dictate the choice in either way.

6. **Following up the decision:** In spite of their best endeavour, managers cannot make infallible decision for two reasons. First, some amount of guesswork becomes inevitable in almost every decision. Because of the cost and time involved in analysing the problem, all facts cannot be secured. Secondly, wrong decisions arise from the limited capacity of the manager himself. As a consequence, it is idle to expect that managers would be making correct decisions in all cases. Any active and responsible manager is bound to make some incorrect decisions along with his frequently correct decisions. The fear of incorrect decision prevents many managers from taking any decision at all. However, as a safeguard against this incorrect decision, managers are required to institute a system of follow-up to decisions so as to modify them at the earliest opportunity.

Decisions are reached by individual managers as well by several managers acting in a group. Alternatively group decisions are taken by superior managers in collaboration with their subordinates. Routine decisions are mostly taken by individual managers who can thereby avoid delay, hesitation and deadlocks associated with group-decisions. One-man decisions are the familiar practice in all small businesses, and to some extent, this system prevails in large businesses also. In some cases, however, individual managers do not like to share the power of decision-making with others for the fear of losing their status and prestige in the enterprise. But important and strategic decisions which introduce any change in the organization cannot be made effective without the active support of affected people. Interdepartmental decisions must be taken by the group as a matter of necessity. For putting the decisions into effect, the group participation in decision making has acquired special importance with a view to-winning employee acceptance.

Even when decisions are made by the group, participation in the first two stages of decision making becomes unnecessary. Making diagnosis of the problem and its analysis can best be done by individual managers, and group participation here leads to the procrastination and delay in decision making. But developing alternative solutions and the picking up of the best solution can be more effectively done through group participation, which improves the quality of decisions by securing benefits of different ideas, suggestions and experiences. There are, however, some serious limitations of group decisions.

Decision Making and Operations Research

In recent years, the scope of intuitive judgment in decision making is gradually being curtailed and a greater emphasis has been put on quantitative approach involving the use of mathematics and statistics. This quantitative approach to decision making is referred to as operation research. Operation research has proved itself to be an invaluable technique of decision making, particularly with regard to planning and controlling functions of management. Operation research found its first application during World War II in the analysis of military problems in Great Britain. Operations research utilizes the applied mathematical and statistical methods to find out some basic pattern of relationships among the number of variable factors in any operating situation. Basically, it applies the probability and sampling theories for mathematical analysis and synthesis of a problem through the establishment of significant relationship.

The various factors of a problem are reduced into quantitative terms for mathematical measurement and analysis. Effects of these chosen factors or situations are also estimated by assignment of quantitative values. From the quantifying values, models are constructed in terms of mathematical equations. With the help of

these equations, possibilities of all alternatives are clearly revealed. To apply operations research for the analysis of business problems, the entire enterprise is looked upon as a group of related activities with common objectives. Otherwise, the quantitative technique may give misleading results from what is known as "sub-optimization". The development of electronic computers has facilitated the growth of operations research for finding out the best course of action along with its probabilities and potentialities.

Application of Operations Research

The quantitative analysis of business problems is made through a number of techniques and tools, such as linear programming, probability theory, sampling theory, queuing theory or waiting line theory, simulation, dynamic programming (e.g., the Programme Evaluation and Review Technique or PERT), operational gaming (e.g., the business game), input-output analysis, search theory and formal game theory. Of the different tools and techniques of operations research, the first five are of proven value and the last five have limited or little application in their present state of development. Lindsay, Franklin A. in his book New Techniques for Management Decision Making, holds the view that probability theory, simulation and operational gaming will have a major impact on management in the near future. Varied business problems that have been subjected to quantitative analysis by operations research include production scheduling, control of production runs in oil refineries, purchasing policies, capital budgeting, freight and transportation costs, assignment of salesmen to market areas, pricing, selection of advertising media and location of plant, store or warehouse. The American Management Association in its Report No. 20 in 1958, Operations Research Reconsidered, has indicated the results of a survey of the industrial application of operations research, and it is found in the Report that areas like production,

long-range planning, sales and marketing and inventory have seen the greatest application of operations research.

Limitations of Operations Research

There are a number of limitations of operations research, which may be stated as follows:

1. In the quantitative analysis of operations research, certain assumptions and estimates are made for assigning quantitative values to factors involved. If such estimates are wrong, the result would be equally misleading.

2. Many management problems do not lend themselves to quantitative measurement and analysis. Intangible factors of any problem concerning human behaviour cannot be quantified accurately and all the patterns of relationships among the factors may not be covered. Accordingly, the outward appearance of scientific accuracy through the use of numbers and equations becomes unrealistic.

3. The quantitative methods of operations research are in many cases costly, elaborate and sophisticated in nature. Although complex problems are fit for analysis by tools of operations research, relatively simple problems have no economic justification for this type of quantitative analysis.

4. A knowledge of some concepts of mathematics and statistics is prerequisite for the adoption of quantitative analysis by managers. According to the present training and experience of most managers, the actual use of these tools may be confined to a few cases.

5. Operations research is not a substitute for the entire process of decision making and it does not relieve

managers of their task of decision making. In one phase of decision making, viz., selection of best solution through the evaluation of alternatives, operations research comes into the picture. Managers have to prepare the groundwork for the introduction of operations research through several steps in decision making viz., diagnosis of problem, analysis of problem and development of alternatives ; and even after the selection of best solution by operations research, managers have to put the decision into effect and to institute a system of follow-up.

DECISION MAKING AND MANAGEMENT INFORMATION SYSTEMS

The "systems" approach to the information flow throughout the enterprise has been of valuable assistance to rational decision making. To reduce the scope of subjective judgment in decision making and to increase the supply of facts to managers for their decisions, the information system has added a new dimension to the decision-making process and has been recognized as a new concept of top-management functions. It is an all-inclusive system for providing management with better information for effective decision making. It is partly a by-product of computer technology, which dictates centralization of data handling and information development for the benefit of the entire organization. Under the computer technology, functions of data manipulation, calculation and data storage (or, as they are collectively called "data processing") can be performed accurately with a terrific speed and at a comparatively lower cost. Primary data or items of raw information are mainly created in certain areas of the business like production, purchasing, sales and personnel. These primary data in varying combinations are fed into the computer centre as input for being processed into various kinds of information as output. Because of the systems approach, the whole organization is looked upon as one entity with

interrelated parts, which are provided with desired information from a common centre through the processing of primary data in various ways.

In the past, data manipulation through manual operation used to take place separately in different functional areas of the business. As a result, a number of defects crept into office work and clerical operations, viz., duplication of effort, multiplicity of reports, lack of requisite information, inaccurate and untimely information and utter inefficiency in office work. All these defects have been eliminated by the integration of data handling and information development .activities under one agency of data processing. Activities concerning not only data processing, but office systems, operations research and others as well have been organized as a top-level job under the "management services" manager. The development of this information system is expected to improve the process of decision making by permitting managers to base their decisions on greater information, to enlarge their visions for developing alternatives, to make a thorough and speedy analysis of problems and to comprehend in a better way the impact of their decisions on the enterprise and its objectives.

Self Assessment Questions

1. Discuss the role and importance of decision making in the management process.

2. Explain the approaches from which vital decisions can be distinguished from routine decisions with a view to determining their authority-level for decision making.

3. Analyse the steps in decision making along with the execution of such decisions.

4. Discuss the bases for decision making. What is the pertinent basis for quick decision making?

5. Explain the nature and significance of participative decision making.

6. Explain the nature, uses and limitations of operations research as a tool for decision making.

7. Discuss how the systems approach has improved the flow of communication for more effective and rational decision making.

UNITE-II
LESSON-3
TRANSPORTATION MODELS AND ASSIGNMENT MODELS

INTRODUCTION

All linear programming problems can be solved by simplex method, but certain special problems lend themselves to easy solution by other methods. One such case in that of Transportation problems.

Transportation problems are encountered in physical distribution of goods. Source of supply, availability of material or commodity for distribution, the requirement of demand at particular place or destination or at number of destinations are some of the parameters involved in the problem. The objective is to minimise the cost associated with such transportation from places of supply to place of demand within given constraints of availability and level of demand. These distribution problems are amenable to solution by a special type of LP model known as Transportation Model. It can also be applied to the maximisation of some utility value such as financial resources.

PROBLEM STATEMENT

Let a_i = quantity of product available at origin i

b_j = quantity of product required at destination j

c_{ij} = cost of transporting one unit of product from origin i to destination j

X_{ij} = quantity transported from origin i to destination j

Assume that $\sum_{i=1}^{m} a_i = \sum_{i=1}^{n} b_j$

It is the case when demand is fully met from the origin. The problem can be stated as LP problem in the following manner.

Min (total cost) Z = $\sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}$

Subject to $\sum_{j=1}^{n} x_{ij} = a_i$ for i = 1, 2, 3, ... m

$\sum_{i=1}^{m} x_{ij} = b_j$ for j = 1, 2, 3, ... n

and $x_{ij} \geq 0$ for all i = 1, 2, 3, ... n

j = 1, 2, 3, ... m

This can be represented as a matrix within a matrix of the dimensions mxn. One matrix is the unit cost matrix which represents the unit transportation cost for each of the possible transportation routes. Superimposed on this matrix is the matrix in which each cell contains a transportation variable, *i.e.,* the number of units shipped from the row-designated origin to the column designated destination. The amount of supplies *ai* available at source i and amount demanded *bj* at each destination *j, i.e.,* a_i*'s* and b_j's represent supply and demand constraint. The problem can be solved either by simplex method already explained in the previous chapters or by transportation method.

SOME USEFUL INFORMATION

1. In the transportation model, the two parameters i.e., supply and demand have some cumulative total. Thus, it can be said that the material available for supply can be supplied because the demand exists at the same level. It is a case of balanced transportation problem. In actual life situation, the demand may exceed the supply available or vice versa. It is termed as an unbalanced transportation problem.

2. When the number of positive allocations in the feasible solution is less than (rows + columns -1), the solution is said to be degenerate. For feasibility criterion, $m + n - 1$ = number of allocations (m = number of rows, n = number of columns in the matrix).

3. Wherever there is a positive allocation to a particular transportation cell, it is called an occupied cell. Other cells of the matrix are treated as empty or unoccupied cells.

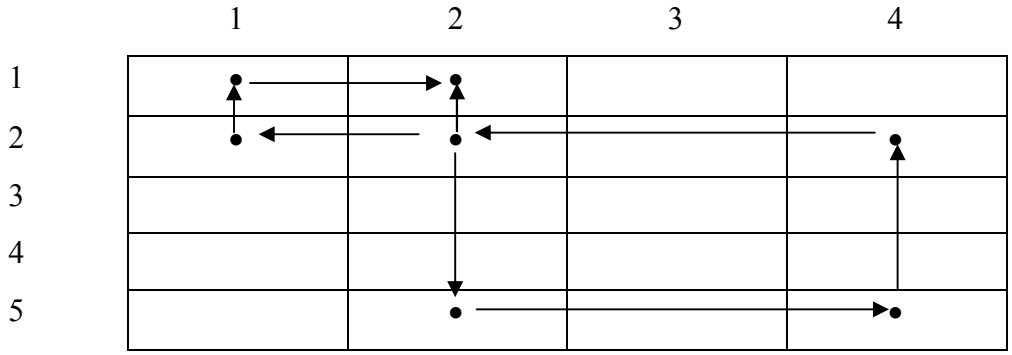
LOOPS IN THE TRANSPORTATION TABLE

Since any basic feasible solution must contain (m + n - 1) independent non-zero allocations, where m x n is the size of the transportation matrix i.e., row x column numbers, independent non-zero allocations imply that we cannot form a closed circuit (loop) by joining positive allocations by horizontal and vertical lines only. Hence, for the formation of a loop, following conditions must satisfy.

1. Any two adjacent cells of the ordered set lie either in the same row or in the same column.

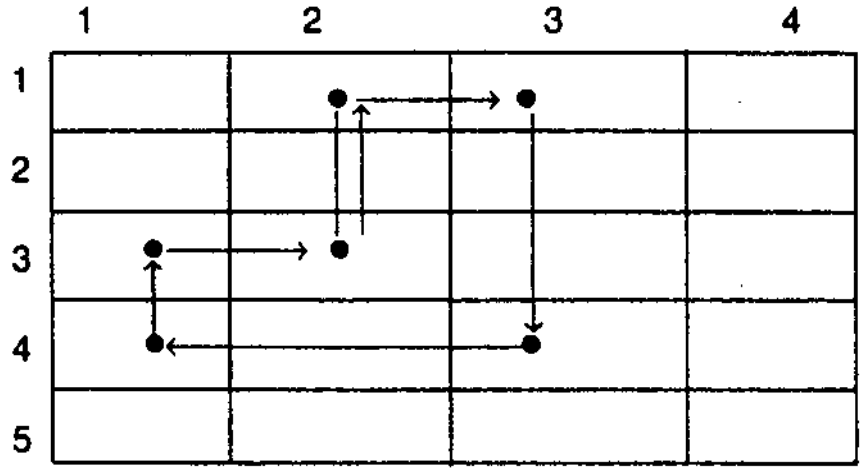
2. Three or more adjacent cells in the ordered set lie in the same row or the column. The first cell of the set must be the last in the set.

   To illustrate the above conditions, let us consider the following table.



The ordered set of cells contain the following allocated cells, (1, 1), (1, 2), (2, 1), (2, 2), (5, 2), (2, 4), (5, 4). The loop formation is for cells (1, 1) (1, 2) (2, 1) and (2, 2) and cells (2, 2), (2, 4), (2, 4) and (5, 2) as (2, 2) appears twice. Whereas the loop formation in the following table satisfies all conditions.

The loop (1, 2), (1,3), (3,4), (4,1), (3,1), (3,2) and (1,2) is feasible loop satisfying all the conditions of loop formation.



Thus, we can say that

1. Every loop has an even number of cells and the least being four.
2. The allocations are in independent position, if it is not possible to reduce or increase the independent individual allocation without altering the position of allocation.
3. Each row and column in the matrix should have only one plus and minus sign. The loop must start with an empty cell and all other cells forming the loop must be occupied or allocated cells.
4. Closed loop may or may not be rectangular in shape.

STEPS IN TRANSPORTATION METHOD

The solution of the transportation problem has the following algorithm

Step 1. Formulate the problem and establish the transportation matrix or table, the cells indicating the parameters value for various combinations *i.e.,* cost, profit, time, distance etc.

Step 2. Obtain an initial basic solution. This can be done in three different ways *i.e.,* North-West Corner Rule, Least Cost Method or the Vogel's Approximation Method.

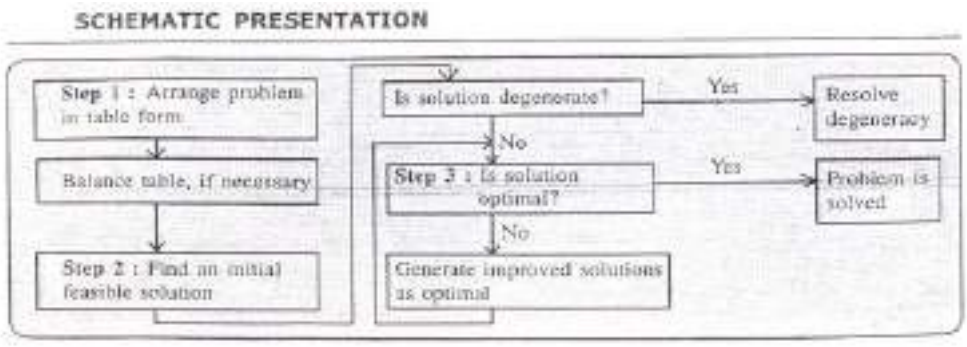
The initial basic solution from any of the methods named above should satisfy the following conditions.

(i) The solution must be feasible, satisfying allocation all supply requirement into demand position.

(ii) The number of positive allocations must be equal to m+ n - 1, otherwise the solution will become degenerate.

Step 3. Test the initial solution for optimality—This is done either by Stepping Stone Method or by MODI Method.

Step 4. Update the solution *i.e.,* applying step 3 till optimal feasible solution is obtained.



TRANSPORTATION MATRIX OR TABLE

The illustration of the transportation model can best be represented by taking an example. The matrix is written as follows.

To / From	D	E	F	Supply
A	6	4	1	50
B	3	8	7	40
C	4	4	2	60
Demand	20	95	35	150

A, B, C are sources of supply and D, E, F the destinations of demand. The matrix indicates the cost of transportation per unit item from source A, B, C to the destination D, E, F.

METHODS OF SOLVING TRANSPORTATION PROBLEM

Following methods can be used for solving transportation problem:

1. North-West Corner Rule (N.W. Corner Rule) or DENTZY's Method.
2. Least Cost Method (LCM)
3. Vogel's Approximation Method (VAM).

North-West Corner Rule

Initial basic feasible solution can be obtained as follow :

(a) If $a_1 > b_1$ assign b_1, in the cell in the first column of the first row. Then put x_{11} = bi and proceed horizontally to the next column in the first row until the supply of this origin is exhausted.

(b) If $a_1 < b_1$, assign the value equal to a_1 as the value of x_{11} and then proceed vertically below to the next row until the demand of this destination is satisfied.

(c) If $a_1 = b_1$, then put the value of x_{11} equal to a_1 or b_1 and then proceed diagonally to the cell determined by the next column of the next row.

In this way, move horizontally until a supply source is exhausted, vertically down until a destination demand is satisfied and diagonally, when the demand at the destination matches exactly the supply available, until the South-East Corner is reached.

Least Cost Method (LCM)

The NW corner rule given above considers only the availability and supply requirement in making assignments, without giving any thought to the involvement of cost. It is, therefore, not a sound solution, as it ignores the most important factor 'Cost' which is to be determined or optimised.

The Least Cost Method can be applied in the following way :

Step 1. Select the lowest cost cell in the whole matrix i.e., out of all values of rows and columns of the transportation table. In case of a tie, select arbitrarily.

Step 2. Allocate maximum possible units considering the supply as well as demand values to this selected lowest cost cell.

Step 3. Eliminate the row or column satisfied fully by the above allocation, if feasible.

Step 4. Adjust the capacity and requirement (supply/demand) for the remaining values after the above allocation.

Step 5. Repeat Step 1 to 4 for the reduced cost table until all the capacities and requirements are fully satisfied.

Vogel's Approximation Method (VAM)

This is a preferred method over other two methods due to its solution being either optimal or very near optimal. This may reduce the time for optimal calculations.

1. Consider each row of the cost matrix individually and find the difference between two least cost cells in it. Then repeat the exercise for each of the columns. Identify the column or row with the largest value difference. In case of tie, select any one (it is wise to select the row or column to give allocation at minimum cost cell). Now consider the cell with the minimum cost in the column (or row, as the case may be) and assign the maximum units possible, considering the demand and supply positions corresponding to that cell. Assign only one cell at a time.
2. Delete the column/row, which has been satisfied.
3. Again, find out the differences of least cost cells and proceed in the same way. Continue until all units have been assigned.

The Vogel's Approximation Method is also called the Penalty Method because the cost differences that it uses are nothing but the penalties of not using the least cost route. Since the objective function is the minimisation of the transportation cost, in each iteration that route is selected which involves the maximum penalty of not being used.

TESTING THE OPTIMALITY

Having obtained the initial basic feasible solution by any of the three methods described above, we have to test the solution, if we have reached the optimal level. We can do this by two methods.

1. Stepping Stone Method.
2. Modified Distribution (MODI) Method.

Stepping Stone Method

By using stepping stone method, we calculate the opportunity cost of each empty cell. We find out as to what effect on the total cost would be if one unit is assigned to any empty cell. The total cost level would indicate if it is more than that obtained by initial

feasible solution. If cost is reduced, solution is not optimal. If it does not, then we have reached optimal solution.

Things to Remember

1. In the stepping stone method, the occupied cells or the circled members are called stones and the cells containing these circled numbers are called stone cells. The unoccupied cells are called water cells.

2. The cells used for re-allocation are given plus and minus signs. Wherever we wish to increase the allocation, it is given plus sign, and when we want to reduce allocation, it is given minus sign. This would mean increase or reduction of transportation costs.

3. Closed loop starts with the unoccupied cell whose additional allocation is being tested, but has to have minimum of three occupied cells to work out the optimality. Horizontal and vertical moves are made in clockwise direction through these occupied cells only. This is primarily to ensure that any increase in a row/column must be compensated by equivalent reduction to balance the supply/demand or capacity requirement conditions.

MODI Method

The modified distributions method (MODI method) can also be used for testing the optimality of the solution obtained for a transportation problem. This is called U - V method also. By this method, the solution can be gradually improved heading towards the optimal value.

Following steps are to be followed to apply this method for the optimality test of the problem.

Step 1. For a given solution of the transportation problem in the form of allocated and unallocated cell matrix, we calculate auxiliary variables the U_i for i = 1, 2, 3..... *m* V_j tor j = 1, -

2.....*n*. for ows and column respectively. The values of U_i and V_j are calculated by using the relationship C*ij* = U*i* + V*j* for all i, j for all occupied cells. To start, U_i or V_j can be selected as zero arbitrarily for the allocation row/column.

Step 2. For unallocated or unoccupied cells. Δ_{ij} can be calculated by the relationship Δ_{ij} = Cij -(Ui + Vj)

where Δ_{ij} is called cell evaluation index or the opportunity index.

Step 3. If $\Delta_{ij} > 0$ then optimal solution has been reached.

If $\Delta_{ij} = 0$, the solution remains unchanged and an alternate solution is feasible.

If $\Delta_{ij} < 0$, there can be an improved solution by introducing cell (i, j) in the basis.

Step 4. We select an unallocated cell with maximum negative opportunity cost of all unallocated cells.

Step 5. Follow a closed path for the unoccupied/unallocated cells obtained in step 4 and assign + (plus) and - (minus) alternately starting with plus for the selected unallocated cell.

Step 6. Now assign largest units possible to the unallocated cell satisfying problem conditions, the smallest allocation in a cell with the minus sign on the closed path will indicate the number of units that can be shifted to the unallocated cell. This quantity is added to all the allocation cell on the closed path marked with plus sign and subtracted from those allocated cells with minus sign.

Step 7. Calculate cost of transportation from the modified allocations and repeat the process through steps 1 to 7 till we reach all the values of $\Delta_{ij} \geq 0$. This would indicate the optimal solution of the problem. The transportation cost (optimal) can now be calculated with this modification.

The above mentioned procedure can best be explained by its application to an actual problem and obtaining the optimal cost by the iteration process described above.

DEGENERACY

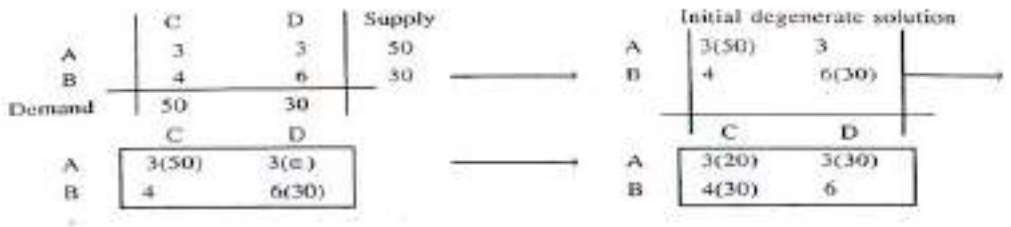
For a feasible transportation optimal solution, there should been m+ n – 1 occupied cells or allocations, whenever the number of occupied cells is less than m + n - 1, the solution is called "degenerate" and it cannot be tested for optimality. Therefore, a special procedure need to be followed as under.

Degeneracy in the initial feasible solution—In this case, we allocate (every small amount) to the empty cell of the solution, to bring the allocation to the desired level (i.e., m + n- 1). It is to be done to the least cost empty cell in minimisation problem. The problem is then solved as if it were non-degenerate. Optimality check can now be conducted. If this assignment of to the least cost cell is not lending the problem for optimality test, then to be assigned to second lowest cell instead and so on.

Degeneracy in the intermediate solution—In this case, $\in$ is assigned to one or more of the newly vacated cells. Having brought the solution to m + n - 1 occupied cells level, optimality test can be carried out.

As an example, following problem can be considered.

Now instead of 2, there are 3 allocations = 2 + 2-1, hence feasible solution.



Now instead of 2, there are 3 allocations = 2+2-1, hence feasible solution.

Assignment Model

INTRODUCTION AND FORMULATION

The assignment problem is a particular case of transportation problem in which the number of jobs (or origins or sources) are equal to the number of facilities (or destinations or machines or persons and so on). The objective is to maximise total profit of allocation or to minimise the total cost. An assignment is a completely degenerate form of a transportation problem. The units available at each origin and the units demanded at each destination are all equal to one.

Mathematical Formulation of an Assignment Problem

Given *n* jobs (or activities) and n persons (or facilities) and effectiveness (in terms of cost, profit, time and others) of each person for each job, the problem lies in assigning each person to one and only one job so that the given measure of effectiveness is optimised.

Let c_{ij} be the cost of assigning *i*th person to the *j*th job. The assignment problem can be stated in the form of *n x n cost matrix or effectiveness matrix* $\{c_{ij}\}$ as shown in the Table.

Persons \ Jobs	1	2	3	...	j	...	n	Supply
1	c_{11}	c_{12}	c_{13}	...	c_{1j}	...	c_{1n}	1
2	c_{21}	c_{22}	c_{23}	...	c_{2j}	...	c_{2n}	1
3	c_{31}	c_{32}	c_{33}	...	c_{3j}	...	c_{3n}	1
⋮								
i	c_{i1}	c_{i2}	c_{i3}	...	c_{ij}	...	c_{in}	1
⋮								
n	c_{n1}	c_{n2}	c_{n3}	...	c_{nj}	...	c_{nn}	1
Demand	1	1	1	...	1	...	1	n

Let x_{ij} denote the assignment of person *i* to job *j* such that

$$x_{ij} = \begin{cases} 1 & \text{if person } i \text{ is assigned to job } j \\ 0 & \text{otherwise} \end{cases}$$

The assignment problem is simply the following LPP:

Minimise $Z = \sum_{i=1}^{n} \sum_{j=1}^{n} c_{ij} x_{ij}$

subject to the constraints

$\sum_{j=1}^{n} x_{ij} = 1$, for i 1 =1,2, … n

and $\sum_{i=1}^{n} x_{ij} = 1$ for j = 1, 2, … n

with x_{ij} = 0 or 1, for all i and j.

Note that an assignment problem is an n x n transportation problem with each $a_i = b_j = 1$.

Assignment problem is completely a degenerate form of a transportation problem. The units available at each origin and units demanded at each destination are all equal to one. This means exactly one occupied cell in each row and each column of the transportation table, that is, only n occupied cell place of the required n + n – 1 = 2n – 1 occupied cells.

Because of degeneracy, the problem cannot be solved by either simplex method or transportation method. For example, in a simplex method, for a problem involving five persons/jobs, there will be 5x5=25 decision variables and 2x5=10 inequalities. It is difficult to solve this problem manually.

In a transportation method, in order to remove degeneracy, (n - 1) number of dummy allocations will be required to proceed with the transportation model. The problem of degeneracy at each solution makes the computation by the transportation method inefficient.

So, we go for a method called the **Hungarian method** developed by the Hungarian mathematician D. Konig to find the optimal solution without having to make a direct comparison of every solution.

HUNGARIAN ASSIGNMENT ALGORITHM

First, we prove the following theorems which form-the basis of the assignment algorithm.

Theorem

The optimum assignment schedule remains unaltered if we add or subtract a constant to/from all the elements of the row or column of the assignment cost matrix.

Proof. Let we add or subtract a constant say u_i, v_j to/from all the elements of the i^{th} row and j^{th} column of the cost matrix. The new cost matrix is $c^*_{ij} = cij \pm u_i \pm v_j$. The objective function is

$$z^* = \sum_{i=1}^{n} \sum_{j=1}^{n} (c_{ij} \pm u_i \pm v_j)\, x_{ij}$$

$$= \sum_{i=1}^{n} \sum_{j=1}^{n} c_{ij}\, x_{ij} \pm \sum_{i=1}^{n} \sum_{j=1}^{n} u_i x_{ij} \pm \sum_{i=1}^{n} \sum_{j=1}^{n} v_j x_{ij}$$

$$= z \pm U \pm V$$

where, $$U = \sum_{i=1}^{n} u_i \left[\sum_{j=1}^{n} x_{ij} \right] = \sum_{i=1}^{n} u_i \text{, since } \sum_{j=1}^{n} x_{ij} = 1$$

and, $$v = \sum_{j=1}^{n} v_j \left[\sum_{i=1}^{n} x_{ij} \right] = \sum_{j=1}^{n} v_j \text{, since } \sum_{i=1}^{n} x_{ij} = 1$$

Note that U and V are constants, hence an assignment (x_{ij}) which minimises z will also minimise z*.

Theorem

If for an assignment problem all $c_{ij} \geq 0$ then assignment schedule (x_{ij}) which satisfies $\sum\sum x_{ij}\, c_{ij} = 0$, must be optimal.

These theorems can be used in two different ways to solve the assignment problem. If in an assignment problem some cost elements are negative we convert the problem into an equivalent assignment

problem with all cost elements as non-negative by adding a suitable large constant to the elements of the relevant row or column. Next, we look for a feasible solution which has zero assignment cost after adding suitable constants to the elements of various rows and columns. Since it has been assumed that all the cost elements are non-negative, this assignment must be optimum.

Hungarian Assignment Algorithm

Various steps of the computational procedure for obtaining an optimal solution may be summarised as follows.

Step 1 : If the number of rows are not equal to the number of columns and vice-versa, then a dummy row or dummy column must be added with zero cost elements.

Step 2 : Find the smallest cost in each row of the cost matrix. Subtract this smallest cost element from each element in that row. Therefore, there will be at least one zero in each row of this new matrix which is called the first reduced cost matrix.

Step 3 : In the reduced cost matrix, find the smallest element in each column. Subtract the smallest cost element from each element in that column. As a result, there would be at least one zero in each row and column of the second reduced cost matrix.

Step 4 : Determine an optimum assignment as follows:

(i) Examine the rows successively until a row with exactly one zeros is found. Box around the zero element as an assigned cell and cross out all other zero in its column. Proceed in this manner until all the rows have been examined. If there are more than one zero in any row, then do not consider that row and pass on to the next row.

(ii) Repeat the procedure for the columns of the reduced cost matrix. If there is no single zero in any row or column of the reduced matrix, then arbitrarily choose a row or column having the minimum number of zeros. Arbitrarily, choose zero

in the row or column and cross the remaining zeros in that row or column.

Repeat steps (i) and (ii) until all zeros are either assigned or crossed out.

Step 5 : An optimal assignment is found, if the number of assigned cells equals the number of rows (and columns). If a zero cell is arbitrarily chosen, there may be an alternate optimum. If no optimum solution is found (some rows or columns without an assignment), then go to next step.

Step 6 : Draw the minimum number of horizontal and/or vertical lines through all the zeros as follows:

(i) Mark (✓) to those rows where no assignment has been made.

(ii) Mark (✓) to those columns which have zeros in the marked rows.

(iii) Mark (✓) rows (not already marked) which have assignments in marked columns.

(iv) The process may be repeated until no more rows or columns can be checked.

(v) Draw straight lines through all unmarked rows and marked columns.

Step 7 : If the minimum number of lines passing through all the zeros is equal to the number of rows or columns, the optimum solution is attained by an arbitrary allocation in the positions of the zeros not crossed in step 3. Otherwise go to the next step.

Step 8 : Revise the cost matrix as follows:

(i) Find the elements that are covered by a line. Choose the smallest of these elements and subtract this element from all the uncrossed elements and add the same at the point of intersection of the two lines.

(ii) Other elements crossed by the lines remain unchanged.

Step 9 : Go to step 4 and repeat the procedure till an optimum solution is attained.

Example

Solve the assignment problem represented by the matrix.

	1	2	3	4	5	6
A	9	22	58	11	19	27
B	43	78	72	50	63	48
C	41	28	91	37	45	33
D	74	42	27	49	39	32
E	36	11	57	22	25	18
F	3	56	53	31	17	28

Solution :

Step 1 :

(i) Subtract the smallest element in each row from all the elements in that row.

(ii) Subtract the smallest element in each column from all the elements in that column.

The reduced matrix is as follows.

	1	2	3	4	5	6
A	0	13	49	0	0	13
B	0	35	29	5	10	0
C	13	0	63	7	7	0
D	47	15	0	20	2	0
E	25	0	46	9	4	2
F	0	53	50	26	4	20

Step 2: Make the zero-assignment as shown. Since row 2 and column 5 have no assignment, go to the next step. See the following Table.

	1	2	3	4	5	6
A	~~0~~	13	49	[0]	~~0~~	13
B	~~0~~	35	29	5	10	~~0~~
C	13	~~0~~	63	7	7	[0]
D	47	15	[0]	20	2	~~0~~
E	25	[0]	46	9	4	2
F	[0]	53	50	26	4	20

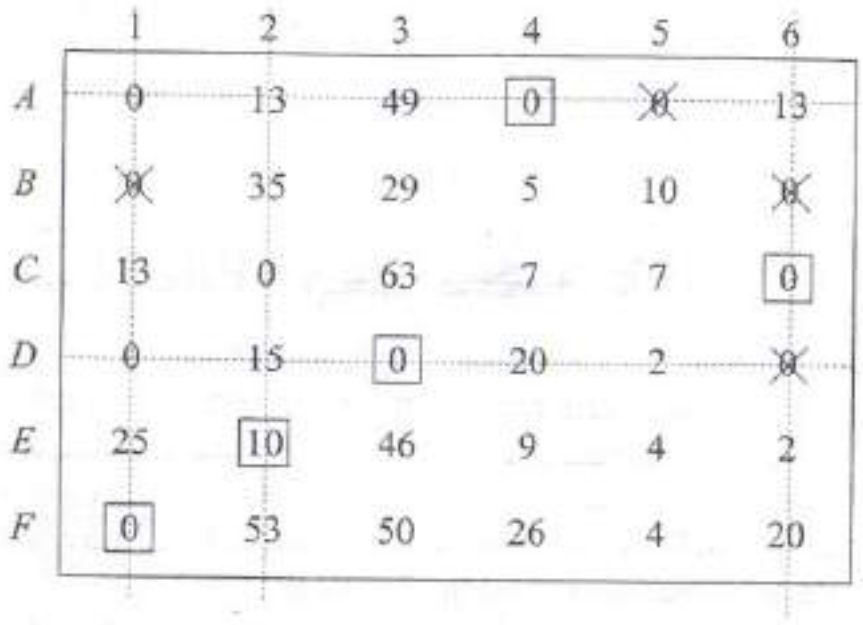
Step 3 : Mark (✓) in row 2 as it is not having an assignment and in columns (1 and 6) as they are columns of ticked row 2 having zero's.

Next, mark ✓ to the rows (3 and 6) as these two rows contain assignment in marked columns (1 and 6).

Next, in marked row 3, there is zero in column.2. Assignment is made made in this column which come sponds to row. So, mark ✓ to row 5 and column 2.

	1	2	3	4	5	6	
A	~~0~~	13	49	[0]	~~0~~	13	
B	~~0~~	35	29	5	10	~~0~~	✓
C	13	~~0~~	63	7	7	[0]	✓
D	47	15	[0]	20	2	~~0~~	
E	25	[0]	46	9	4	2	✓
F	[0]	53	50	26	4	20	✓
	✓	✓				✓	

Step 4 : Draw straight lines through unmarked rows and marked columns as shown below.



	1	2	3	4	5	6
A	0	13	49	[0]	~~0~~	13
B	~~0~~	35	29	5	10	~~0~~
C	13	0	63	7	7	[0]
D	0	15	[0]	20	2	~~0~~
E	25	[10]	46	9	4	2
F	[0]	53	50	26	4	20

Since the number of lines is five which is less than the number of rows or columns, we move to the next step to get the optimal solution.

Step 5 : The smallest element among all uncovered elements is 4. Subtract 4 from all elements not covered by lines and add 4 to all the elements that lie at the intersection of this lines. A reduced matrix is formed. Then, make zero assignments as shown below.

	1	2	3	4	5	6
A	4	17	49	[0]	~~0~~	17
B	[0]	35	25	1	6	~~0~~
C	13	~~0~~	59	3	3	[0]
D	51	19	[0]	20	2	4
E	25	[0]	42	5	~~0~~	2
F	~~0~~	53	46	22	[0]	20

The other solution is:

	1	2	3	4	5	6
A	4	17	49	0	~~0~~	17
B	~~0~~	35	25	1	6	0
C	13	0	59	3	3	~~0~~
D	51	19	0	20	2	4
E	25	~~0~~	42	5	0	2
F	0	53	46	22	~~0~~	20

Hence, the optimal assignments are:

(i) $A \rightarrow 4, B \rightarrow 1, C \rightarrow 6, D \rightarrow 3, E \rightarrow 2, F \rightarrow 5$
(ii) $A \rightarrow 4, B \rightarrow 6, C \rightarrow 2, D \rightarrow 3, E \rightarrow 5, F \rightarrow 1.$
with minimum cost z = Rs 142.

5.3 VARIATIONS OF THE ASSIGNMENT PROBLEM

1. Non-square matrix (unbalanced assignment problem)

The Hungarian method of assignment requires that the number of columns and rows in the assignment matrix must be equal. When the given cost matrix is not a square matrix, then the problem is called an unbalanced problem. In this case dummy row(s) or column(s) with zero cost is added to make it a square matrix. These cells are treated the same way as the real cells during the process. Then, adopt the Hungarian method to find the solution.

2. Maximisation problem

There may be problems of maximising the profit, revenue, and so on. Such problems may be solved by converting the given maximisation problem into a minimisation problem before Hungarian method is applied. The transformation may be done in the following two ways:

(i) by subtracting all the elements from the highest element of the matrix,

(ii) by multiplying the matrix elements by - 1.

3. Multiple optimal solutions

While making an assignment in the reduced assignment matrix, it is possible to have two or more ways to strike off certain number of zeros. Such situation leads to multiple solutions with the same optimal value of objective function. In such cases the most suitable solution may be considered by the decision-maker.

4. Restrictions on assignments (or) impossible assignment

Cells in which assignments are not allowed are assigned a very heavy cost (written as M or ∞) Such cells are prohibited to enter into the final solution.

UNIT II

LESSON NO. 4

CPM, PERT NETWORK ANALYSIS

CRITICAL PATH METHOD (CPM)

After the construction of a project s network its time analysis becomes essential for planning various activities of the project. The duration of individual activities may be uniquely determined (in case of CPM) or may involve three time estimates (in case of PERT) out of which the expected duration of an activity is computed.

The main objective of time analysis is to prepare the planning schedule of a project. The planning schedule should include the following factors:

(i) Total completion time for the project.

(ii) Earliest time when each activity can start.

(iii) Latest time when each activity can be started without delaying the total project.

(iv) Float for each activity, that is, the amount of time by which the completion of an activity can be delayed without delaying the total project completion.

(v) Identification of critical activities and critical path.

Notations: We shall use the following notations for basic scheduling computations:

(ij) or i-j = Activity (i,j) with tail event i and head event j.

T_E or Ei = Earliest occurrence time of event i

T_L or Lj = Latest allowable occurrence time of event j.

D_{ij} = Estimated completion time (duration of activity (i, j)

ES_{ij} (or) $(ES)_{ij}$ = Earliest starting time of activity (i,j)

EF_{ij} (or) $(EF)_{ij}$ = Earliest finish time of activity (i,j)

LS_{ij} (or) $(LS)_{ij}$ = Latest starting time of activity (i,j)

LF_{ij} or $(LF)_{ij}$ = Latest finishing time of activity (i, j)

For calculating the above mentioned times, we shall discuss two methods, namely forward pass computation and backward pass computation.

Forward Pass Computation (for Earliest Event Time)

In this method, calculations begin from the initial event, proceed through the network visiting events in an increasing order of event number and end at the final event. At each event we calculate earliest occurrence event time (T_E or E_i) and earliest start and finish time for each activity that begins at that event. When calculations end at the final event, its earliest occurrence time gives the earliest possible completion time of the entire project.

(i) Set the earliest occurrence time of initial event as zero.

(ii) The earliest starting time of activity (i, j) is the earliest event of the tail end event, that is, $(ES)_{ij}$, = E_i.

(iii) The earliest finish time of activity (i,j) is the earliest starting + the activity duration. That is,

$$(EF)_{ij} = (ES)_{ij} + D_{ij}$$

or, $$(EF)_{ij},= E_i + D_{ij}$$

(iv) The earliest event time for event j is the maximum of the earliest finish times of all activities ending into that event. That is,

E_j = max [$(Ef)_{ij}$ for all immediate predecessor of (i,j)]

E_j = max [$E_i + D_{ij}$].

Backward Pass Computation (for Latest Allowable Time)

In this method calculations begin from the final event, proceed through the network visiting events in the decreasing order of event numbers and end at the initial node. At each event, we calculate the latest occurrence event time T_L or L_j for the corresponding event, latest finish and start time for each activity that is terminating at the event, such that the earliest finish time for the project remains the same.

(i) For ending event assume E = L. Remember that all Es have been computed by forward pass computation.

(ii) The latest finish time for activity (i,j) is equal to the latest event time of event j, $(Lf)_{ij} = L_j$

(iii) The latest starting time activity (i, j) = the latest completion time of (i, j) the activity time (duration)

or, $(LS)_{ij} = (Lf)_{ij} - D_{ij}$

or, $(LS)_{ij} = L_j - D_{ij}$

(iv) Latest event time for event t is the minimum of the latest start time of all activities originating from that event.

That is,

L_i = = $_{min}$ [$(LS)_{ij}$ for all immediate successors of (i, j)]

$$= \min_{j} [LF)_{ij} - D_{ij}]$$

$$= \min_{j} [L_j\text{-}D)_{ij}].$$

Computation of Float and Slack Time

After calculating the earliest and latest occurrence time the next step is to calculate the floats as defined below:

Total float (TF or $(TF)_{ij}$) of an activity is defined as the difference between the latest finish and the earliest finish of the activity or the difference between the latest start and the earliest start of the activity.

i.e. $TF = (TF)_{ij} = (LS)_{ij} - (ES)_{ij}$

or, $(TF)_{ij} = (LF)_{ij} - (EF)_{ij}$

This is the most important type of float because it concerns with the overall project duration.

Total float of an activity is the amount of time by which that particular activity may be delayed without affecting the duration of the project.

Free Float (FF or $(FF)_{ij}$) of an activity is that portion of the total float which can used for rescheduling that activity without affecting the succeeding activity.

That is, $FF = FF_{ij}$ = Total float of i-j - $(T_L - T_E)$ of the event j

where, T_L = Latest occurrence Time

T_E = Earliest occurrence Time

Independent Float (IF or IF_{ij} of an activity is the amount of time by which an activity can be rescheduled without affecting the preceding or succeeding activities of that activity.

IF = IF_{ij} = Free float of i-j - (T_L -T_E) of the event i.

The negative value of independent float is considered as zero.

Remarks

1. The relation between the three floats is given by Independent float ≤ Free float ≤ Total float.

2. The concept of floats is useful to the management in representing under-utilised resources and flexibility of the schedule and the extent to which the resources will be utilised on different activities.

3. The floats can be used for redeployment of resources to level the same or to reduce project duration. However, one should bear in mind that whenever the float in a particular activity is utilised, the float of not only that activity but that of other activities would also change.

Event slacks: For any given event, event slack is defined as the difference between the latest event d earliest event times.

For a given activity i - j,

Head event slack = L_j, - E_j

Tail event slack = L_j – E_i

The floats can be represented in terms of head and tail event slacks also.

Total float = $L_j - E_i - D_{ij}$

Free float = $E_j - E_i - D_{ij} = (L_{ij} - E_i - D_{ij}) - (L_j - E_j)$

= Total float - Head event slack

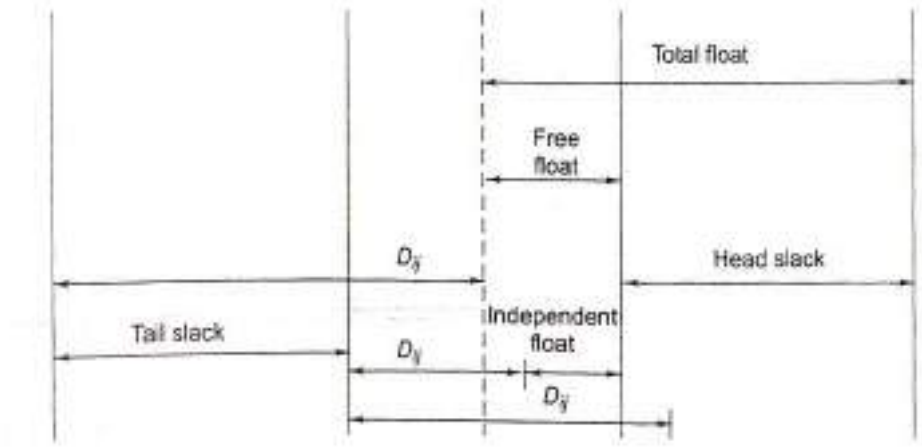
Independent float = $E_j - L_i - D_{ij}$

= $(E_j - E_i - D_{ij}) - (L_i - E_j)$

= Free float - Tail event slack.

Time Scale Representation of Floats and Slacks

The various floats and slacks for an activity i-j can be represented on a time scale as follows:



Conclusions drawn from total values

From the value of a total float we can draw the following conclusion:

If the total float is positive then it may indicate that the resources for the activity are more than adequate. If the total float of an activity is zero, it may indicate that the resources are just adequate for that activity. If the total float is negative, it may indicate that the resources for that activity are inadequate.

Critical Path

Critical event: Since the slack of an event is the difference between the latest and earliest event times, that is, slack (i) = L_i – E_i, the events with zero slack times are called critical events.

That is, the event (i) is said to be critical if E_i, = L_i.

Critical activity: Since the difference between the latest start time and earliest start time of an activity is usually called as total float, the activities with zero total float are known as-critical activities.

That is, an activity is said to be critical if a delay in its start will cause a further delay in the completion date of the entire project.

Critical path: Path connecting the first initial node to the very last terminal node, of longest duration in any project network is called the critical path.

That is, the sequence of critical activities in a network is called the critical path. Double or darker lines may be used to denote the critical path.

Main Features of Critical Path

1. If a project has to be shortened, then some of the activities on the critical path must also be shortened. The application of additional resources on other activities will not give the desired result unless the critical path is shortened first.

2. The variation in actual performance from the expected activity duration time will be completely reflected in a one-to-one fashion in the anticipated completion of the whole project.

PROJECT EVALUATION AND REVIEW TECHNIQUE (PERT)

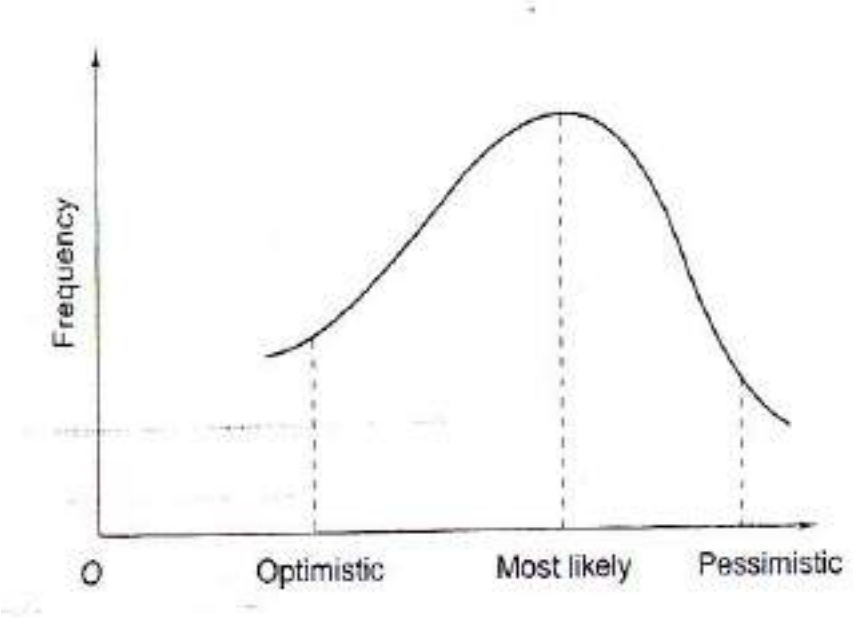
This technique, unlike CPM, takes into account the uncertainty of project durations. If the duration of activities in a project is uncertain, then activity scheduling calculations done using the expected value of the durations. However, such expected duration estimation may not give an accurate answer. Thus, rather than estimating directly the expected completion time of an activity, three values are considered. From these, a single value is estimated for future consideration. This is called three-time estimates- PERT.

1. Optimistic time estimate (t_0 or a) is the duration of any activity when everything goes on well during the project. That is, labourers are available and come in time, machines are working properly, money is available whenever needed, there is no scarcity of raw material needed and so on.

2. Pessimistic time estimate (t_p or b) is the duration of an activity when almost everything goes against our will and a lot of difficulties are faced while doing a project.

3. Most likely time estimate (t_m or m) is the duration of an activity when some things go on well and some thing go wrong while doing a project.

These three time values are shown as under



Time distribution curve

Two main assumptions made in PERT calculations are:

1. The activity durations are independent. That is, the time required to complete an activity will have no bearing on the completion time of any other activity of the project.

2. The activity duration follow β distribution. β distribution is a probability distribution with density function $K\{t - a)^{\alpha}$ $(b - t)^{\beta}$ with mean $t_e = \frac{1}{3}[2t_e + \frac{1}{2}(t_0 + t_p)]$ and standard deviation $\sigma = \frac{t_p - t_0}{6}$

PERT Procedure

Step 1: Draw the project network.

Step 2: Compute the expected duration of each activity $t_e = \frac{t_0 + 4t_m + t_p}{6}$

Step 3: Compute the expected variance σ^2 of each activity.

Step 4: Compute the earliest start, earliest finish, latest start, latest finish and total float of each activity.

Step 5: Determine the critical path and identify critical activities.

Step 6: Compute the expected variance of the project length (also called the variance of the critical path) σ^2_c which is the sum of the variances of all the critical activities.

Step 7 : Compute the expected standard deviation of the project length σ_c and calculate the standard normal deviate $\frac{T_s - T_E}{\sigma_c}$

Where T_s=specified or scheduled time to complete the project

T_s = normal expected duration (duration of the project)

σ_c=expected standard deviation of the project length

NETWORK ANALYSIS

Any management system revolves around utilisation of human as well as non-human resources. It is generally observed that for carrying out management function, the resources are at premium. Hence an efficient manager is one who optimises his inputs to achieve the best and gets maximum out of his resources under most trying conditions. While motivation of human resources plays a very major role in accomplishing the tasks by a given schedule, the optimisation of the non-human assets for varied and large number of activities, therefore, needs certain tried out techniques to be applied.

Completion of any project by a certain definite time schedule is the essence of any management challenge. The organisation has to decide the goal or the mission of the project in very clear terms and then plan the work by working out resources for its completion. The

scheduling of the activities will be based on three important constraints.

(a) Time schedule.

(b) Money constraint.

(c) Manpower and equipment constraints.

Within the above constraints, the detailed planning of the project must be carried out based on

1. Mission of the project objective of the management.

2. Extent of control desired critically of the project.

3. Resources and techniques available for control.

Network techniques are the pictorial representation of the activities and their interrelationship to help in the planning, scheduling and controlling the project. In simple and small level project, there may not be a requirement of use of very sophisticated techniques, but when project is very large and there are very complex activity relationship with resources being very limited, network techniques come to the help of the project manager in a big way.

Though there are quite a few such techniques available today along with effective software packages like MS-project and Primavera, the discussion is restricted to the basic technique of CPM (Critical Path Control) and PERT (Programme Evaluation and Review Technique). Though most commonly used and most easily understood techniques of Bar-Chart and Gantt-chart are still in use for small projects, large projects need de ailed planning and control, thereby needing the use of CPM and PERT with newer and latest softwares mentioned above.

CPM and PERT were developed in late 1950 s, though quite independently, but with the same purpose and using the same terminology. The minor variation is that PERT was used for dealing with uncertainties in activity completion time. The major strength of CPM was its ability to take care of the trade-off facility in terms of time and cost variations i.e., it caters for additional resources for counteracting time over-run and vice-versa. In the present context, the difference between CPM and PERT has largely vanished.

Widely diverse projects are amenable to analysis by PERT and CPM. Few of them are listed below:

1. Research and development programme
2. Construction of a plant
3. Building a mega project of irrigation
4. Launching of a space-ship
5. Over-haul of an organisation
6. Training of manpower
7. Starting an Adult Literacy programme
8. Arranging a dinner/Cocktail party

METHODOLOGY OF NETWORK TECHNIQUES

Planning is basically a process of working out specific number and types of activities with their associated time schedules. The work is to be logically and methodically structured into a step by step planing framework, where CPM/PERT are used extensively. The methodology of planning leading to the use of these techniques can be described as below.

Project Identification and Definition—Analysis of job is an initial step of planning work. This would include the determination of set of activities and their sequence of performance for proper implementation.

Resources Planning—Based on the quantum of work under each activity, the resources need be calculated in terms of personnel, equipment, time, cost, materials etc. specifying level of skills, type and efficiency of the equipment, time schedule with reference to inter-relationship of various activities, the quantum and schedule of availability of money required and the details of materials as per Master work schedule.

Project Scheduling—We now work out a detailed layout of the activities with specific time schedule.

Project Control—Control methodology by the use of Network system is a must for monitoring the progress of work in terms of its physical and financial set up. Alternate plans of 'what-if' analysis must also be prepared by using Network system extensively.

OBJECTIVES OF THE NETWORK ANALYSIS

The use of Network analysis is made in achieving following objectives—

1. Minimisation of total project cost.

2. Minimisation of total project time.

3. Trade-off between the time and cost of the project.

4. Optimisation of human and non-human resources.

5. Minimisation of conflicts, delays and interruptions.

ADVANTAGES OF NETWORK ANALYSIS

Network Techniques are handy tools for a project manager to achieve the following advantages :

Planning Stage—listing out activities and then sequencing, resources planning and estimation of cost and time for various activities. This helps in defining the total project.

Scheduling Stage—working out inter-relationships amongst various activities, their inter-dependence and possible improvements, scheduling of flow path of activities and associated resources. This would indicate the largest schedule called critical path of the project. This helps in getting the quantum of optimal resources.

Controlling Stage—Having used Network techniques extensively for planning and scheduling of the project, these become effective tools for monitoring and controlling the time and cost schedules. Constant review, bringing status report into focus, can help in reallocation of resources wherever bottlenecks are noticed. Trade-off between time, cost and environmental conditions can be achieved effectively.

BASIC RULES OF NETWORK ANALYSIS

Basically CPM or PERT use a graphical presentation depicting the project in its entirety. Networks can be drawn for different levels of project such as project level, sub-project level, tasks and activities levels etc. While drawing out these graphical forms of Network, some conventions or basic rules have to be followed. The rules for establishing the Network system are enumerated below :

1. A decision-maker prepares the list of activities and their inter-dependence and inter-relationships. Each activity is represented by a

circle called node or event and an arrow, i.e., one activity should have only one arrow representing it as given in Fig. 33.1 below :

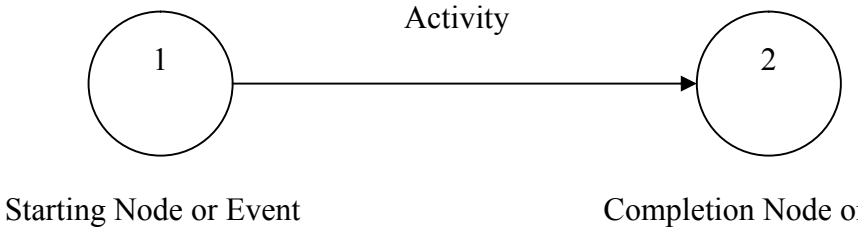


Fig.1

It assures that time flows in the forward direction, but the length of an arrow has no significance as to decide proportionality of time.

2. Each activity must have a preceding and a succeeding event. Hence an activity is designated by a pair of preceding and succeeding events so numerically numbered. The head-events always should have a number higher than that of the tail event. Starting event is the preceding event and completion event is the succeeding event, as 1 and 2 above (Fig. 1).

3. There should be no loops in the project network. The network as given below is NOT permissible.

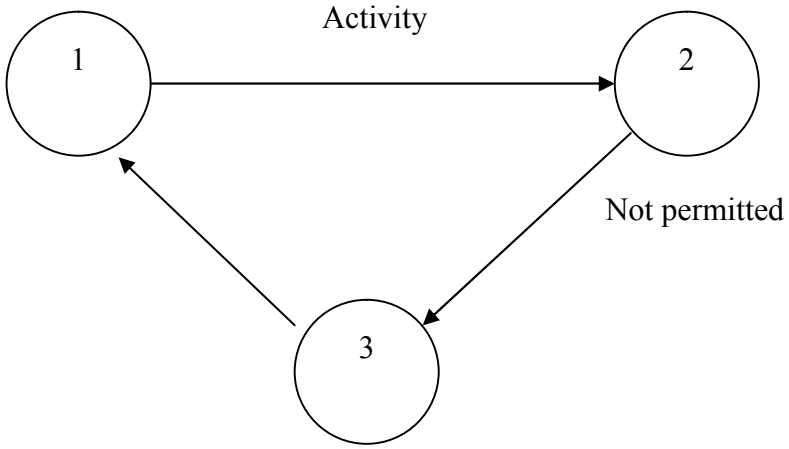


Fig.2

4. There can not be more than one activity having the same preceding and succeeding events. The following is NOT permitted.

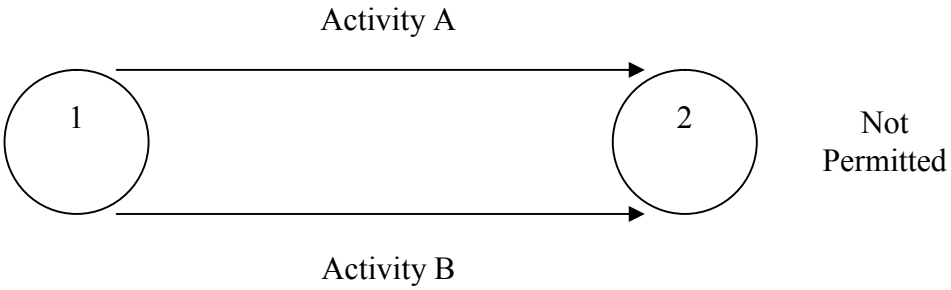


Fig.3

5. The same event can be a preceding or a succeeding activity to more than one activity of the network. This shows the precedence of operations of the project. Numbering of events should be in the order of happening i.e., succeeding event should be numbered only when all the preceding events have been numbered. Generally beginning of the project should be denoted by starting node (single) and end by a single completion node. A situation can be. illustrated like this. Numbering of events have been suggested by Fulkerson's Rule as given above.

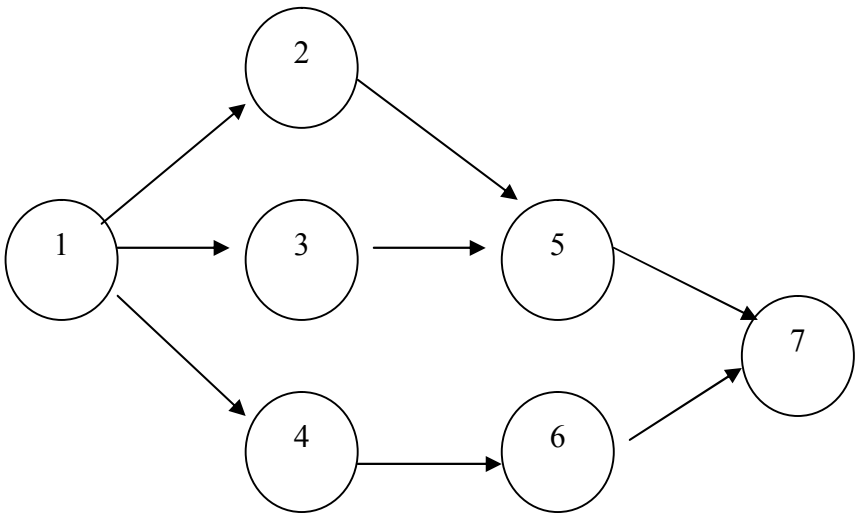


Fig.4

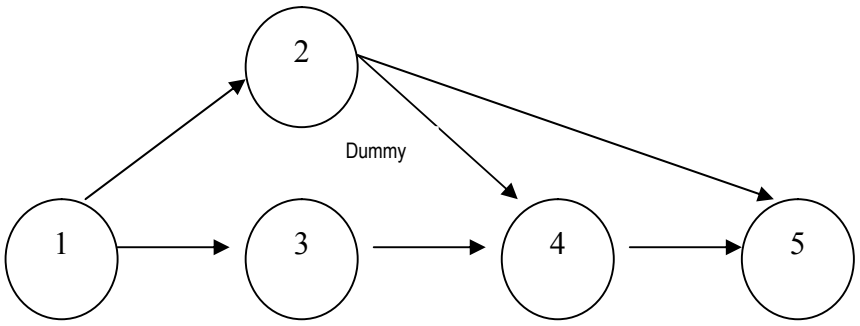


Fig. 5

6. There can be some activities happening simultaneously or concurrently and these are called concurrent activities. In order to establish proper relationship, we use the concept of dummy activity. Dummy activity does not consume time or any other input resources. In Fig. 33.5, activity 1-2 and 3-4 are concurrent activities, but dummy activity 4-2 means that before we undertake activity 2-5, activity 1-2 and 3-4 both should get completed, whereas 4-6 can be undertaken without any reference to 2-5. Similarly in Fig. 33.6, activity 1-2 and 1-3 are concurrent activities. Activity 3-4 can be performed without any relevance of 1-2 being complete or not. But before taking up activity 4-5, activities, 1-2 and 3-4 both should get completed. Thus dummy activity has shown relationships of sequence of such connected activities.

UNIT III

LESSON NO. 5

SYSTEM DEVELOPMENT

Introduction

The system concept were founded in General system theory which enforces a close look at all parts of a system General systems theory is concerned with Developing a systematic, theoretical, framework upon which to make decision. This theory basically concern with the activities of the organization and its external environment. Thus, a system is a way of thinking about organization and their problems. It also involves a set of techniques that helps in solving problems.

The term system is derived from Greek word SYSTEMA, which means an organized relationship among functioning units or components. A system exists because it is designed to achieve one or more objective .we come into daily contact with the transportation system the telephone system the accounting System, the Production System and the computer System.

There are more than a hundred definition of the word System, but some are common used that a System is an orderly grouping of interdependent components linked together according to a plan to achieve a specific objectively. A component may refer to physical parts managerial steps (Planning organizing directing and controlling) or a subsystem in a multilevel structure. The Study or System concepts, then has three basic implications:-

1) A system must be designed to achieve a predetermined objective.

2) Interrelationships and interdependence must exist among the components.

3) The objectives of the organization as a while have a higher priority that the objectives of its subsystems. e.g. Computerizing personnel applications must conform on the organization's policy.

Characteristic of a System

Our definition of a system suggests some characteristics that are present in all systems : organization, interaction, interdependence, integration and a central objective:

1) **Organization:**

Organization means structure and order it is the arrangement of components that helps to achieve Objectives in the design of a business system for example the hierarchical relationships starting with the president on top and leading downward to the workers represents the Organization structure. Such type of arrangement shows a system-subsystem relationship defines the authority structure, species the formal flow of communication, and formalities the chain of command like wise a computer system is designed around an input device, a central processing unit, an output device and one or more storage units. When all these units linked together they work as a whole system for producing information.

2. **Interaction:**

Interaction refers to the manner in which each component or unit functions with other components of the system. In an organization, for example, purchasing must interact with production advertising with sales and payroll with personnel. In a computer system the central processing unit must interact with the input device to solve a problem.

3. **Interdependence:**

Interdependence means that parts of the organization or computer system depend on one another. They are coordinated and linked together according to a plan one subsystem depends on the input of another subsystem for proper functioning in the output of one system is the required input fro another subsystem.

4. Integration:

Integration refers to the Completeness of the systems integration is concerned with how a system is tied together. This means that sharing physical part or location of the system. For better understand parts of the system work together with the system even though each part performs a unique function. Without the properly integration of the system, a system cannot work properly and cannot achieve the desired objective.

5. Central Objective:

The last characteristic of a system is its central objective objectives may be real or stated. Although a stated objective may be the real objective, it is not good for an organization to state one objective and operate to achieve another. The important point is that users must know the central objective of a system for successful design of a system.

Types of Systems

Systems have been classified in different ways common classifications they all are defined below:

1) Physical or Abstract System
2) Open or Closed System
3) Deterministic & Probabilistic System
4) "Man-made" information systems

1. Physical or Abstract Systems:

Physical Systems are tangible entities that may be static or dynamic in operation. E.g. the physical parts of the computer center are the offices, desks and chairs that are helpful for operation in the computer center. They can be seen and counted; they are static. In contrast, a programmed computer is dynamic system. Data programs, output and applications changes as the user's demands. Abstract Systems are conceptual or nonphysical entities. They may be as straightforward as formulas of relationship among sets of variables.

2. Open – Closed System:

An open system continually interacts with its environments. It receives inputs from and delivers output to the outside. An information system belongs to this category, since it must adapt to the changing demands of the users. In contrast, a close system is isolated from environmental influences. In reality completely close systems are Rare.

3. Deterministic or Probabilistic System:

A deterministic system is one in which the Occurrence of all events is perfectly predictable. If we get the description of the system state at a particular time, the next state can be easily predicted. An example of such a system is a numerically controlled machine too. Probabilistic system is one in which the occurrence of events cannot be perfectly predicted. An Example of such a system is a warehouse and its contents.

4. Man-Made Information Systems:

An information system is the basis for interaction between the user and the analyst it provides instructions, commands and feedback it determines the nature of the relationship among decision makers. In fact, it may be viewed as a decision center for personnel at all levels. From this basis, an information system may be defined as a set of devices, procedures and operating systems designed to produce information and communicate it to the user for planning, control and performance. The Major information systems are formal, informal and computer based.

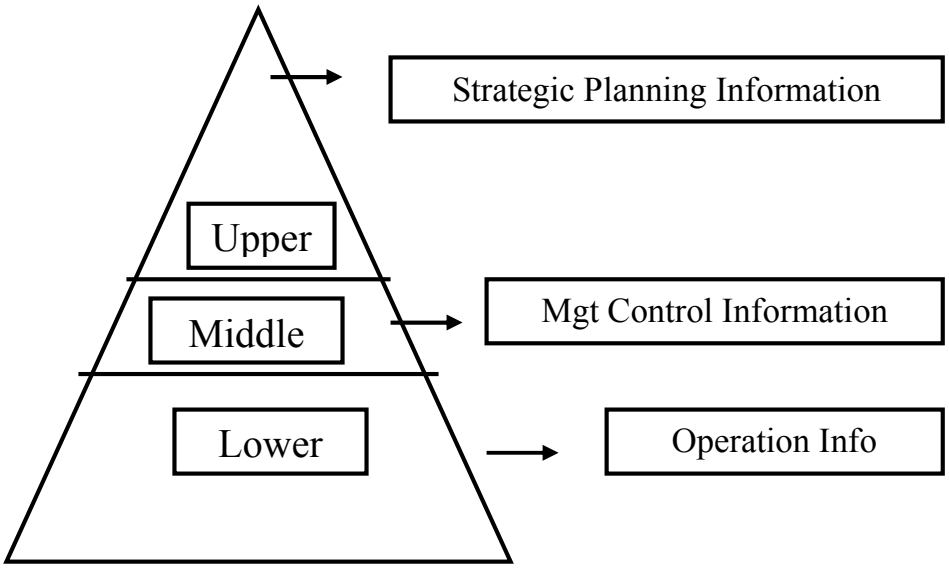
5. Formal Information Systems:

A formal information system is based on the organization represented by the organization chart. The chart is an map of positions and their authority relationships, indicated by boxes and connected by straight lines. This system is connected with the pattern of authority, communication and work flow. Basically, information is collected in

instructions, Memos or reports from top management to the intended user in the organization. In this system Polices are formulated by the Top monument and then translated into directives, rules and regulations and transmitted to lower level management for implementation. The output represents employee performance.

Categories of information:

There are three categories of information related to managerial level. The First level is Strategic information, which relates to long range planning policies that are of direct interest to upper management information such as population growth, trends in financial investment, and human resources changes would be of interest to top company officials.



Management and information Levels in a Typical Organization

The second level of information is ***Managerial Information*** these information is used by middle level management. e.g. sales analysis, cash flow and annual financial statements. Basically, this information is of use in short and intermediate range planning – that is month rather than years.

The Third information level is **Operation Information** which is short term, daily information used to operate departments and enforce the

day to day rules and regulations of the business. Examples are daily employee absence sheets, the current stock available for sale.

Informal Information System:

The formal information system is a power structure designed to achieve company goals. In some cases organization has to communicate with the employees to enhance the performance as well as to make the proper control on the working. As a result, an informal information system develops. It is employee-based system designed to meet personnel needs and to provide necessary help for problem solving. In this respect, it is useful system because it works within the framework of the business and its started policies.

Computer Based Information System:

A third class of information system relies on the computer for handling business applications. For Example Highway System, Railway Systems & Airlines System.

Book

System Development Life Cycle

To understand system development, we need to recognize that a candidate system has a life cycle, just like a living system or a new product. Systems analysis and design are keyed to the system life cycle. The analyst must progress from one stage to another methodically answering key questions and achieving results in each stage.

A word of caution regarding life cycle activities: We isolate and sequence these activities for learning purposes, but in real life they overlap and are highly interrelated. For example, when the analyst is evaluating an existing operation, he/she is probably thinking about an alternative way that would improve the system or wondering whether a given piece of hardware would be critical cost item to consider for a candidate system. Therefore, there can easily be overlap during any

phase of the cycle. In fact, it may act as a basis for modifying earlier steps taken. We now describe each of these steps.

Recognition of Need- What is the Problem?

One must know what the problem is before it can be solved. The basis for a candidate system is recognition of a need for improving an information system or a procedure. For example, a supervisor may want to investigate the system flow in purchasing, or a bank president has been getting complaints about the long lines in the drive-in. This need leads to a preliminary survey or an initial investigation to determine whether an alternative system can solve the problem. It entails looking into the duplication of effort, bottlenecks, inefficient existing procedures, or whether parts of the existing system would be candidates for computerization.

If the problem is serious enough, management may want to have an analyst look as it. Such an assignment implies a commitment, especially if the analyst is hired from the outside. In larger environments, where formal procedures are the norm, the analyst's first task is to prepare a statement specifying the scope and objective of the problem. He/she then reviews it with the user for accuracy. At this stage, only a rough "ball park" estimate of the development cost of the project may be reached. However, an accurate cost, of the next phase – the – feasibility study can be produced.

Impetus for System Change

The Idea for change originates in the environment or from within the firm (figures 1) environment based ideas originate from customers, vendors, government sources, and the like. For example, new unemployment compensation regulations may make it necessary to change the report procedure, format, and content of various reports, as well as file structures. Customer complaints about the delivery of orders may prompt an investigation of the delivery schedule, the experience of truck drivers or the volume of orders to be delivered. When investigated, each of these ideas may lead to a problem definition as a first step in the System life cycle process.

Ideas fro change may also come from within the organization top management, the user, the analyst (Figure 1). As an organization changes its operations or faces advances in computer technology, someone within the organization may feel the need to update existing applications or improve procedures. Here are some examples:

- An organization acquires another organization.
- A local bank branches into the suburbs.
- A department spends 80 percent of its budget in one month.
- Two departments are doing essentially the same work, and each department head insists the other department should be eliminated.
- A request for a new from discloses the sue of bootleg (unauthorized) forms.

Serious problems in operations, a high rate of labor turnover, labor-intensive activities, and high reject rates of finished goods, also prompt top management to initiate an investigation. Other examples are :

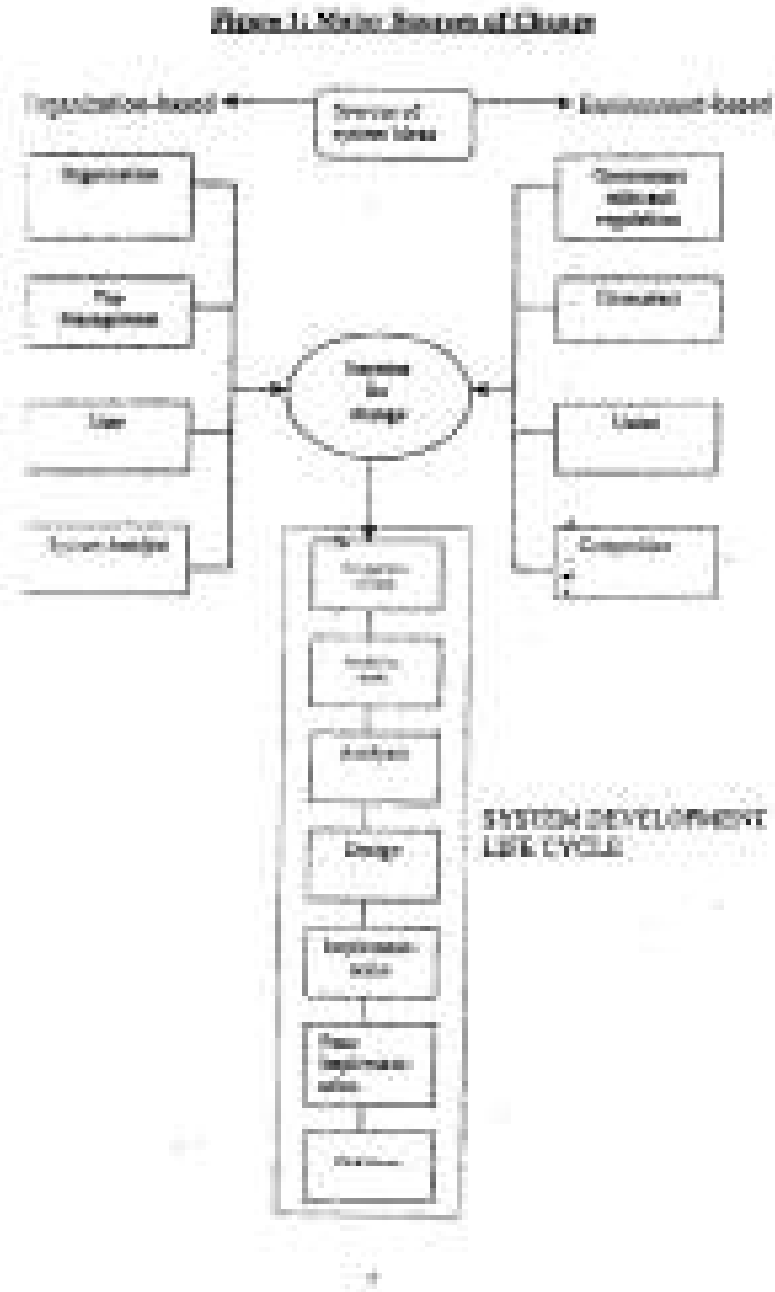
- A report reaches a senior vice president and she suspects the figures.
- The company comptroller reads in IRS audit report and starts thinking.
- An executive read about decision support systems for sales forecasting and it gives him an idea.

Many of these ideas lead to further studies by management request often funneled downward and carried out by lower management. User-oriented ideas also prompt initial investigations. For example, a bank's head-teller has been noticing log customer lines in the lobby. She wants to know whether they are due to the computer's slow response to inquiries, the new tellers' limited training, or just a sudden increase in bank business. To what extent and how quickly a

user-oriented idea is converted to a feasibility study depend on several factors:

- The risk and potential returns.
- Management's bias toward the user.
- Costs and the funds available for system work.
- Priorities of other projects in the firm.
- The persuasive ability of the user.

All these factors are crucial for a prompt response to a user request for change. A systems analyst is in a unique position to detect and even recommend change. Experience and previous involvement in the user's area of operations make him/her a convenient resource for ideas. The role and status of the analyst as a professional add credibility to eh suggestions make:



Feasibility study:

Depending on the results of initial investigation, the survey is expanded to a more detailed feasibility study. A feasibility study is a test of a system proposal according to its workability, impact on the organization, ability to meet user needs, and effective use of resources. It focuses on three major questions:

1. What are the user's demonstrable needs and how does a candidate system meet them?
2. What recourses are available for given candidate systems? Is the problem worth solving?
3. What is the likely impact of the candidate system on the organization? How well does it fit within the organization's master MIS Plan?

Each of these questions must be answered carefully. They involve around investigation and evaluation of the problem, identification and description of candidate systems, specification of performance and the cost of each system, and final selection of the best system.

The objective of a feasibility study is not to acquire a sense of its scope. During the study, the problem definition is crystallized and aspects of the problem to be included in the system are determined. Consequently, costs and benefits are estimated with greater accuracy at this stage.

The result of feasibility study is a formal proposal. This is simply a report – a formal document detailing the nature and scope of the proposed solution. The proposal summarizes what is known and what is going to be done. Its consists of the following:

1. Statement of the problem – a carefully worded statement of the problem that led to analysis.
2. Summary of findings and recommendations – a list of the major findings and recommendations of the study. It is ideal for the user who requires quick access to the results of the analysis of the system under study. Conclusions are stated, followed by a list of the recommendations and a justification for them.
3. Details of findings – an outline of the methods and procedures undertaken by the existing system, followed by coverage of the objectives and procedures of the candidate system. Included are also discussions of output reports, file structures, and costs and benefits of the candidate system.

4. Recommendations and conclusions – specific recommendations regarding the candidate system, including personnel assignments, costs, project schedules, and target dates.

After management reviews the proposal, it becomes a formal agreement that paves the way for actual design and implementation. This is a crucial decision point in the life cycle. Many projects die the here, whereas the more promising one continue through implementation. Changes in the proposal are made in writing, depending on the complexity, size and cost of the project. It is simply common sense to verify changes before committing the project to design.

Analysis:

Analysis is a detailed study of the various operations performed by a system and their relationship within and outside the system. A key question is "What must be done to solve the problem"? One aspect of analysis is defining the boundaries of the system and determining whether or not a candidate system should consider other related systems. During analysis, data are collected on the available files, decision points, and transactions handled by the present system. There are some logical system models and tools that are used in analysis. Data flow diagrams, interviews, on-site observations, and questionnaires are examples. The interview is a commonly used tool in analysis. It requires special skill and sensitivity to the subjects being interviewed. Bias in data collection and interpretation can be a problem. Training, experience, and common-sense are required for collection of the information needed to do the analysis.

Once analysis is completed, the analyst has a firm understanding of what is to be done. The next step is to decide how the problem might be solved. Thus in systems deign, we move from the logical to the physical aspects of the life cycle.

Design:

The most creative and challenging phase of the system life cycle is system design. The term design describes a final system and the

process by while it is developed. It referred to the technical specification (analogous to the engineer's blueprints) that will be applied in implementing the candidate system. It also includes the construction of programs and program testing. The key question here is "How should the problem be solved?" The major steps in design are shown in figures 2.

The first step is to determine how the output is to be produced and in what format. Samples of the output (and input) are also presented. Second, input data and master files (database) have to be designed to meet the requirements of the proposed output. The operational (processing) phases are handled through program construction and testing, including a list of programs needed to meet the system's objectives and complete documentation. Finally, details related to justification of the system and an estimate of the impact of the candidate system on the user and the organization are documented and evaluated by management as a step toward implementation.

The final report prior to the implementation phase includes procedural flowcharts, record layouts, report layouts, and a workable plan, or implementing the candidate system. Information on personnel, money, hardware, facilities and their estimated cost must also be available. At this point, projected costs must be close to actual costs of implementation.

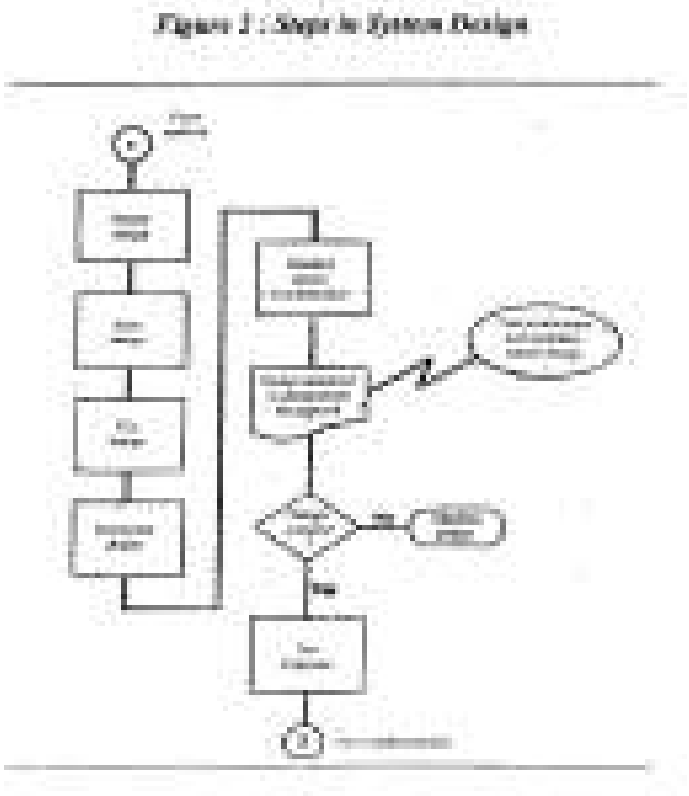
In some firms, separate groups of programmers do the programming, whereas other firms employ analyst-programmers who do analysis and design as well as code programs. In this case, we assume that analysis and programming are carried out by two separate persons. There are certain functions, through that the analyst must perform while programs are being written. Operation procedures and documentation must be completed. Security and auditing procedures must also be developed.

Implementation

The implementation phase is less creative than system design. It is primarily with user training, site preparation and file conversion. When the candidate system is linked to terminals or remote sites, the

telecommunication network and tests of the network along with the system are also included under implementation.

During the final testing, user acceptance is tested, followed by user training. Depending on the nature of the system, extensive user training may be required. Conversion usually tales place at about the same time the user is being trained on later.



In the extreme, the programmer is falsely viewed as someone who ought to the isolated from other aspects of system development. Programming is itself design work, however. The initial parameters of the candidate system should be modified as a result of programming efforts. Programming provides a ‘reality test’ for the assumptions made by the analyst. It is therefore a mistake to exclude programmers from the initial system design. System testing checks the readiness and accuracy of the system to access update and retrieve data from new files. Once the programs become available, test data are read into the computer and processed against the files provided the testing. If successful, the program(s) is then run with “live” data. Otherwise a

diagnostic procedure is used to locate and correct errors in the program. In most conversion, a parallel run is conducted where the new system runs simultaneously with the "old" system. This method though costly, provides added assurance against errors in the candidate system and also gives the user staff an opportunity to gain experience through operation. In some cases, however, parallel processing is not practical. For example, it is not plausible to run parallel two online point-of-sale (POS) systems for a retail chain. In any case, after the candidate system proves itself, the old system is phased out.

Post-Implementation and Maintenance

After the installation phase is completed and the user staff is adjusted to the change created by the candidate system, evaluation and maintenance begin. Like any system, there is an aging process that requires periodic maintenance of hardware and software. If the new information is inconsistent with the design specifications, then changes have to be made. Hardware also requires periodic maintenance to keep in true with design specifications. The importance of maintenance is to continue to bring the new system to standards.

User priorities, changes in organizational requirements, or environmental factors also call for system enhancements. To contrast maintenance with enhancement, if a bank decided to increase its service charges on checking account $ 3.00 to $ 4.00 for am minimum balance of # 300, it is maintenance. However, if the same bank decided to create a personal loan, on negative balances when customers overdraw their account, it is enhancement. This changes evaluation, program modifications and further testing.

Project Termination

A system project may be drooped at any time prior to implementation, although it becomes more difficult and costly when it goes past the design phase. Generally project are dropped if after a review process, it is learned that:

Changing objectives or requirements of the user cannot be met by the existing design.

Benefits realized from the candidate system do not justify commitment to implementation.

There is a sudden change in the user's budget or an increase in design costs beyond the estimate made during the feasibility study.

The project greatly exceeds the time and cost schedule.

In each case, a system project may be terminated at the user's request.

Summary:

- **System:** System means an organized relationship among functioning units or components.
- **Interdependence**: It means that parts of the organization or computer system depend on one another.
- **Analysis: It** is a detailed study of the various operations performed by a system and their relationship within and outside the system.
- **Design :** The term design describes a final system and the process by while it is developed.

Self Assessment Questions

1. What is System? Explain it's Characteristics?
2. What is the difference between the following
   a) Physical & Abstract System
   b) Open & Closed System
   c) Probabilistic & Deterministic System
3. What do you mean by System Analyst? Explain it's role?
4. Explain System Development Life Cycle?
5. What is the role of Feasibility Study in SDLC?
6. How the Business act as a system? Explain?
7. What are the elements of a System? Can you have a viable System without feedback? Explain.
8. How important is the informal information system in system analysis? Explain.

9 What categories of information are relevant to decision making in business ? Relate each category to the management level and an information system.

Suggested Reading

1. Systems Analysis and Design (Hardcover)
   by Alan Dennis, Barbara Haley Wixom, Roberta M. Roth: Course Technology; 4 edition (February 16, 2006Publisher: John Wiley & Sons; 3 edition (October 14, 2005)
2. Systems Analysis and Design Methods (Hardcover)
   by Jeffrey L Whitten, Lonnie D. Bentley Publisher: McGraw-Hill/Irwin; 7 edition (November 22, 2005)
3. Systems Analysis and Design (6th Edition) (Hardcover)
   by Kenneth E. Kendall, Julie E. Kendall Publisher: Prentice Hall; 6 edition (March 1, 2004)
4. Essentials of Systems Analysis and Design, Second Edition (Paperback) by Joseph S. Valacich, Joey F. George, Jeffrey A. Hoffer Publisher: Prentice Hall; 2 edition (March 3, 2003)
5. Modern Systems Analysis and Design (4th Edition) (Hardcover)
   by Jeffrey A. Hoffer, Joey F. George, Joseph S. Valacich
   Publisher: Prentice Hall; 4 edition (May 17, 2004)

UNIT III

LESSON NO. 6 & 7

STRUCTURED ANALYSIS
&
UNSTRUCTURED ANALYSIS

Structured analysis is a set of techniques and graphical tools that allow the analyst develop a new kind of system specifications that are easily understandable to the user analyst work primarily with their wits, pencil and paper. Most of them have no tools. The traditional approach focuses on cost benefit and feasibility analyses, project management, hardware and software selection, and personnel considerations. In contrast structured analysis considers new goals and structured tools for analysis. The new goals specify the following:

1. Use graphics wherever possible to help communicate better with the user.
2. Differentiate between logical and physical systems.
3. Build a logical system model to familiarize the user with system characteristics and interrelationships before implementation.

The structured tools focus on the tools mentioned here – data flow diagram, data dictionary, structured English, decision Trees, and decision tables.

Structured Analysis

The objective of structured to build a new document, called system specifications. This document provides the basis for design and implementation. The system development life cycle

with structured analysis is shown in Figure 1. The primary steps are:

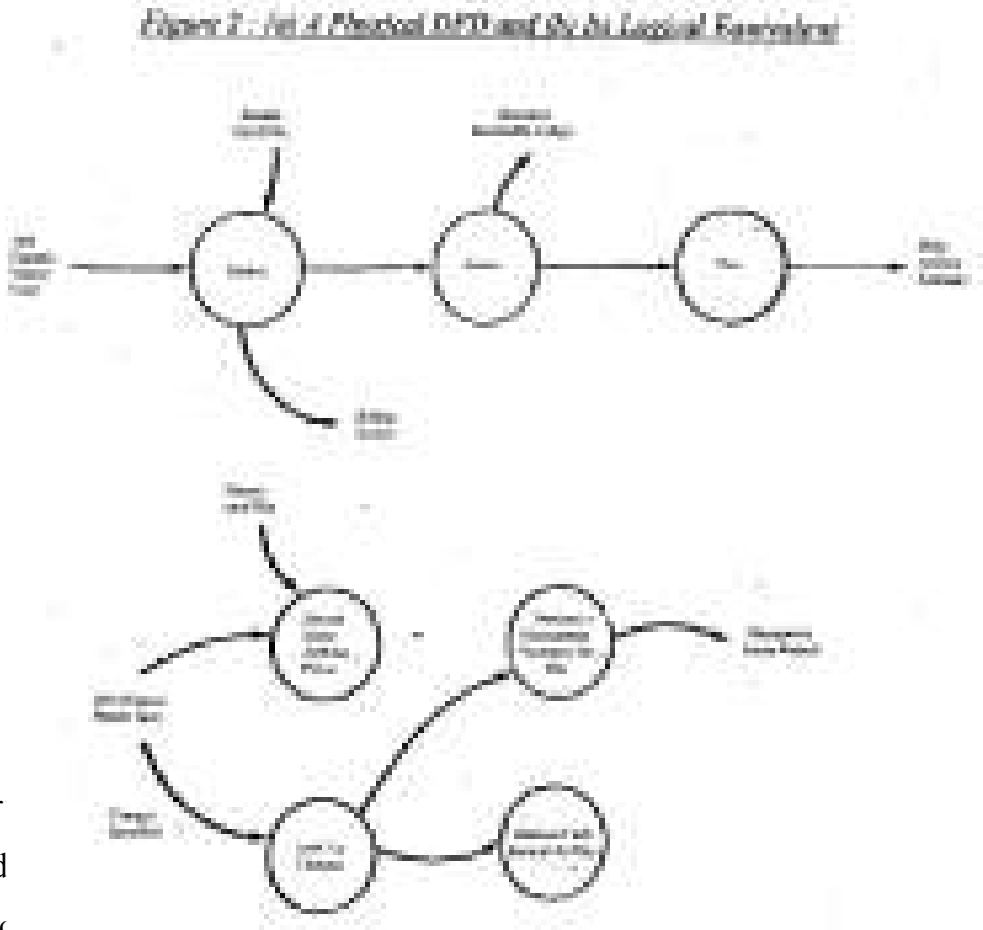
Process 2.1: Study affected user areas, resulting in a physical DFD. The logical equivalent of the present system results in a logical DFD.

Process 2.2: Remove the physical checkpoints and replace them with a logical equivalent, resulting in the logical DFD. To illustrate, consider the two DFD's shown in Figure a. Figure 2(a) is a physical DFD. It shows how the opening of a new safe deposit box flows through the current department. Figure 2(b) is the logical equivalent.

Process 2.3 : Model new logical system. So far no consideration is given to modifying methods called for in the feasibility report. This step incorporates the changes and begins to describe the candidate system. It is essentially a paper model system to be installed.

Process 2.4 : Establish man/machine interface. This process modifies the logical DFD for the candidate system and consider the hardware needed to implement the system. The combination results in the physical DFD of the candidate system.

Process 2.5 and 2.6 : Quantify costs and benefits and select hardware. The purpose of this step is to cost – justify the system, leading to the selection of hardware for the candidate system. All that is left after this step is writing the structured specification.



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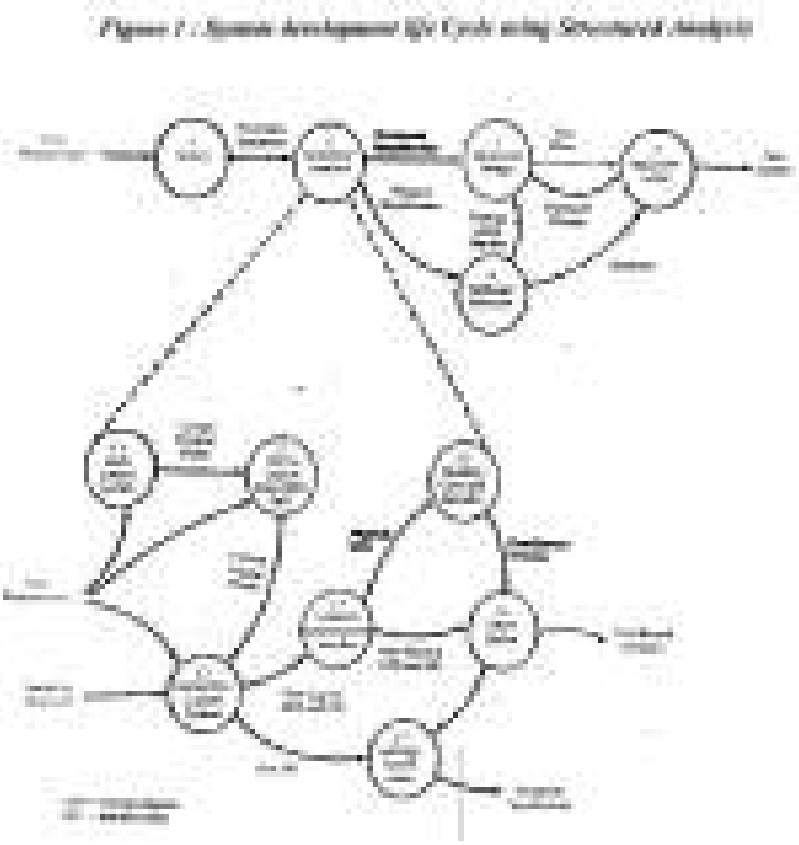
the DFDs, and documentation of the intervals of DFDs in a rigorous manner through structured English, decision trees, and decision tables.

In summary, structured analysis has the following attributes:

1. It is graphic. The DFD, for example, presents a picture of what is being specified and is a conceptually easy – to understand presentation of the application.
2. The process is partitioned so that we have a clear picture of the progression from general to specific in the system flow.



3. It is logical rather than physical. The elements of system do not depend on vendor or hardware. They specify in a precise, concise, and highly readably manner the workings of the system and how it hangs together.
4. It calls for a rigorous study of the user area, a commitment that is often taken lightly ill the traditional approach to system analysis.
5. Certain tasks that are normally carried out late in the system development life cycle are moved to the analysis phase. For example, user procedures are document during analysis rather than later in implementation.

The Tools of Structured Analysis

Let's take a look at the tools of structured analysis using a common illustration ----the textbook publisher. Here is a summary background:

1. ABC, inc. is a multimillion –dollar publisher of business and technical textbooks, located in Homewood , Illinois. The company is organized into division such as trader, textbooks, accounting and sales. The organization structure consists of a president, two senior vice – president, a general manager of each division, shipping and receiving supervisors and 45 sales representatives.
2. The college book division receives order from bookstores for books at a discount that depends on the size of the order. The clerk in charge verifies the order and authorizes shipment though the warehouse. An invoice follows the shipment accounting clerk processes account receivable through the accounting department from forms tined out.
3. Business is highly seasonal; it peaks about a month before the beginning of each school term. There is an average of 80 invoices per week, eah with an average of 8 book titles and average value of $5000.
4. Recently, management decided to improve the availability of textbooks by holding stock of new computer and other high-demand text and making it possible for all bookstore to order by calling a toll- free number as well as by the present mail method. These means that an improved inventory control system must be devised along with a catalog of texts to verify authors and determine the availability of the books being ordered.
5. the new system of receiving order is expected to increase the sales volume by 80 percent within the year. Although fewer average texts per order are expected due to the use of the toll- free number, books are now shipped more quickly than before and delivered in time for the start of the semester.

An analysis has been asked to investigate the new system and build a logical model of the candidate system without abruptly jumping to conclusions what will be automated and what will remain manual.

The Data Flow Diagram (DFD)

The first step is to draw a data flow diagram (DED). The DFD was first developed by Larry Constantine as a way of expressing system requirements in a graphical form; this led to a modular design.

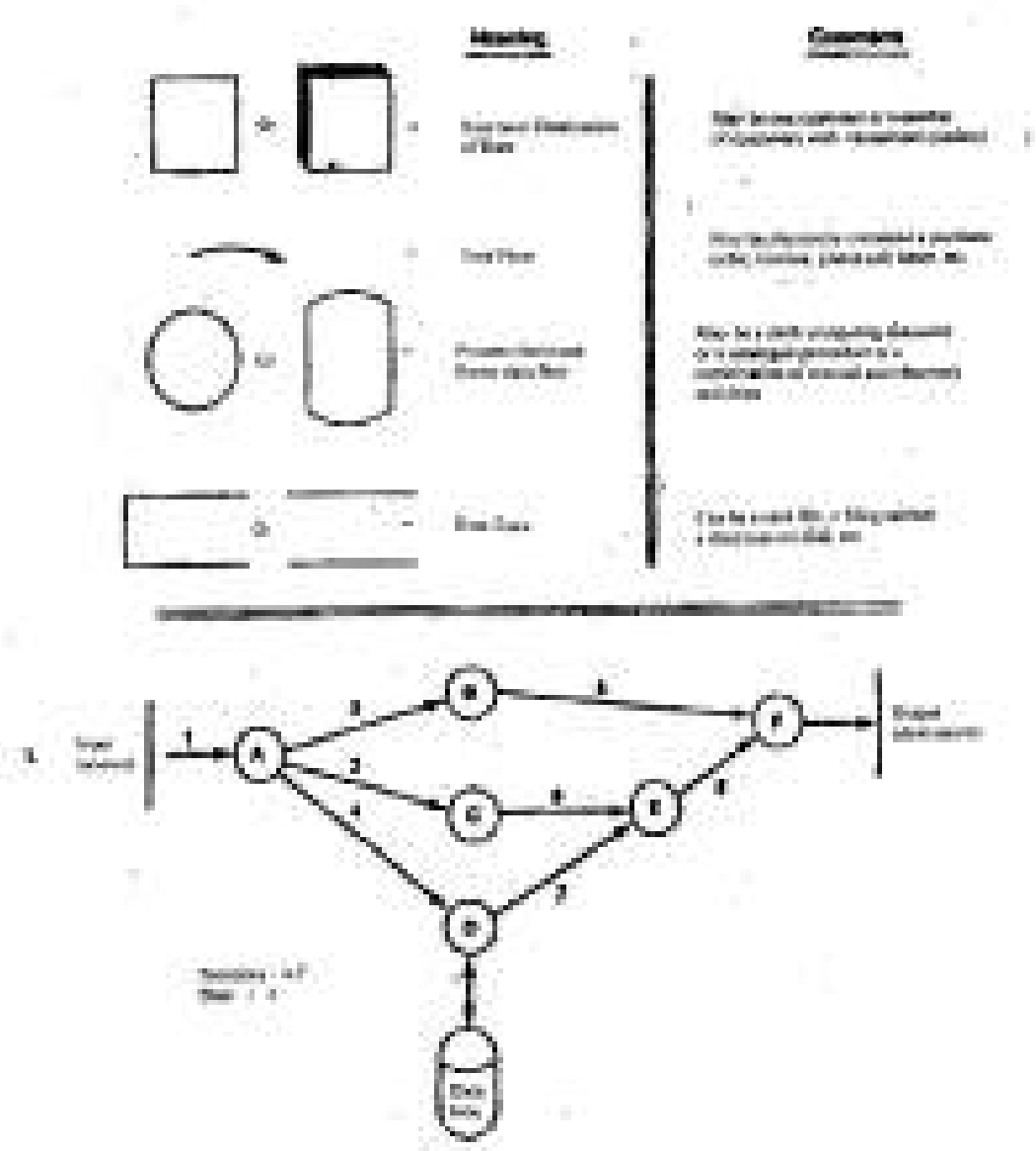
A DFD also known as a bubble chart has the purpose of clarifying system requirements and identifying major transformations that will become programs in system design. So it is the starting point of the design phase that functionally decomposes the requirements specifications down to the lowest level of detail. A DFD consists of a series of bubbles joined by lines. The bubbles represent data transformations and the lines represent data flows in the system.

DFD Symbols:

In the DFD, there are four symbols, as shown in Figure 4 :

1. A square defines a source (originator) or destination of system data.
2. An arrow identifies data flow – data in motion. It is a pipeline through which information flows.
3. A circle or a “bubble” (some people use an oval bubble) represents process that transforms incoming data flow(s) into outgoing data flow(s).
4. An open rectangle is a data store – data at rest, or a temporary repository of data.

Figure 4 : Data Flow Diagram (a) Basic Symbols and (b) General Format



Note how they are processed, so it does not depend on hardware; software, data structure, or file organization. The key question that we are trying to answer is : What major transformations must occur for input to be correctly transformed into output?

Each process summarizes a lot of information and can be exploded into several lower – level, detailed DFDs. This is

often necessary to make sure that a complete documentation of the data flow is available for future reference.

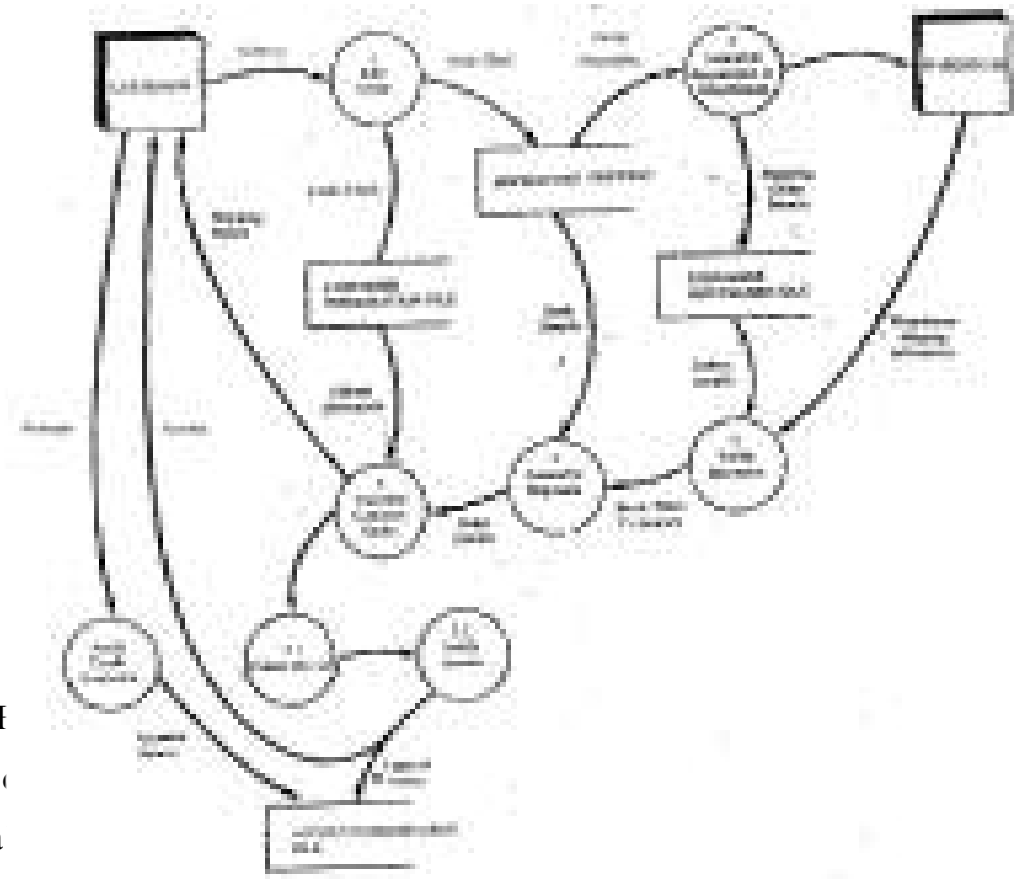
Constructing a DFD

Several rules of thumb are used in drawing DFDs:

1. Processes should be named and numbered for easy reference (see figure 5). Each name should be repetitive of the process.
2. The direction of the flow is from top to bottom and from lest to right. Data traditionally flow from the source (upper left corner) to the destination (lower – right corner), although they may flow back to a source. One way to indicate this is to draw a long flow line back to the source. An alternative way is to repeat the source symbol As a destination. Since it is used more than once in the DFD, it is marked with a short diagonal in the lower right corner (see figure 6).
3. When a process is exploded into lower – level details they are numbered.
4. The names of data stores, sources, and destinations are written in capital letters. Process and data flow names have the first letter of each worked capitalized.

A DFD typically shows the minimum contents of data stores. Each data store should contain all the data elements that flow in and out. Questionnaires can be used to provide information for a first cut. All discrepancies, missing interfaces, redundancies, and the like are then accounted for – often through interviews.

Figure 5 : Completed DFD Showing Accounts Receivable Routine



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understand after a brief orientation. The main problem, however, is the large number of iterations that often are required to arrive at the most accurate and complete solution.

Data Dictionary

A data dictionary is structured repository of data about data. It is a set of rigorous definitions of all DFD data elements and data structures (see figure 7)

Data Dictionary is a Repository of data about the metadata. It contains information about each of the component of DFD, data stores processes and data flowed. DD is a integral part of system specifications since it is an detailed study of the system.

A Data Dictionary has many advantages. The most obvious is documentation it is a valuable reference in any organization. Another advantage is improving analyst / user communication by

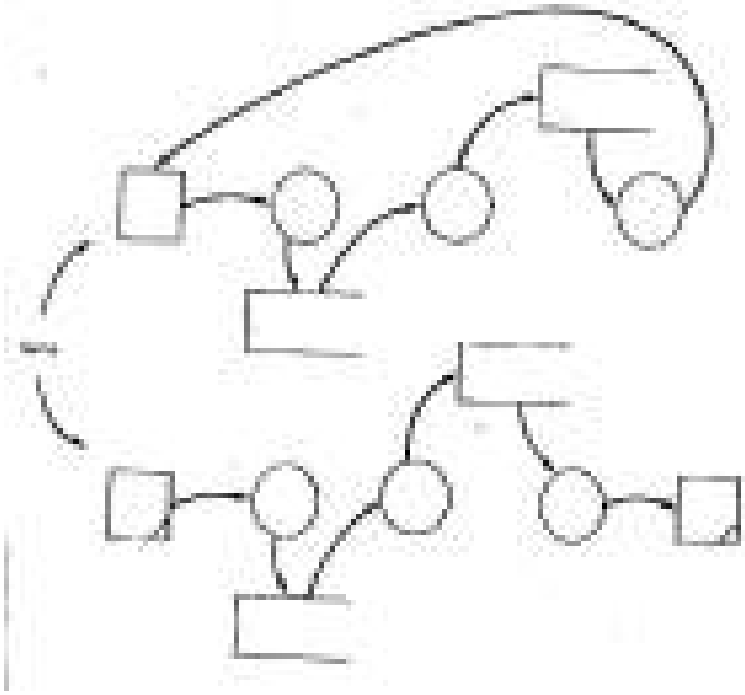
reestablishing consistent definitions of various elements terms and procedures. Finally, a Data dictionary is an important step in building a data base. Most database management systems have a data dictionary as a standard feature.

Description	IMS	CODASYL
Smallest Unit of Data	Field	Data item
Groups of Smallest Data Items	Segment	Data Aggregate
Entity Processed at a Time	Logical Record	Record
Largest Grouping	Data base	Set

A data dictionary has many advantages:

1. The first advantage is documentation; it is a valuable reference in any organization.
2. Another advantage is improving analyst / user communication by establishing consistent definitions various elements, terms and procedures.
3. During implementation, it serves as a common base again which programmers who are working on the system compare their data descriptions.
4. Also control information maintained for each data element is cross-referenced in data dictionary. For example, programs that use a given data element is cross-referenced in a data dictionary, which makes it easy to identify them and make necessary changes.

Figure 6 : Alternative Use of Source / Destination Symbols



5. A data dictionary is an important step in building a database most database management systems have a data dictionary as a standard feature.

Figure 7 : Project Data Element Form – A Sample

PROJECT DATA ELEMENT SHEET

PROJECT NAME _____ DATA _____

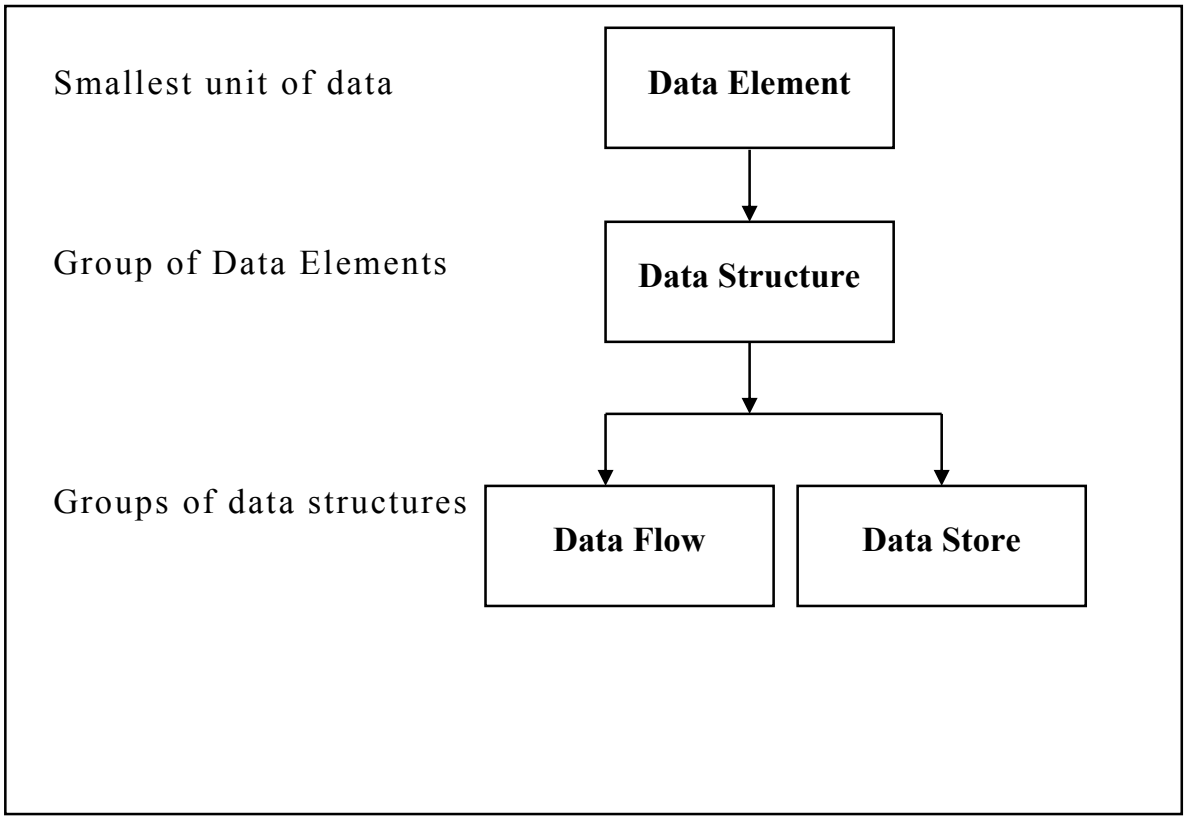
DATA ELEMENT DESCRIPTION	DATA ELEMENT ABBREVIATION	ELEMENT PICTURE	ELEMENT LOCATION	ELEMENT SOURCE

Data have been described in different ways. For example, in tape and disk processing IBM called a file a data set. In database technology, the term file took on a different meaning. IBM Information Management System's (IMS) manual defines data as divided into segments, which, in turn, are combined into databases. The conference on Data System Languages (CODASYL) defines data as data items combined into which, in turn, are combined into records to as a set. A group of related records is referred to as a set. A summary of these data definitions is given in the following table 1 :

Table 1 : Sample Data Definitions

Description	IMS	CODASYL
Smallest Unit of Data	Field	Data Item
Group of Smallest data items	Segment	Data Aggregate
Entity processed at a time	Logical record	Record
Largest grouping	Database	set

Figures 8 : Logical Data Description Hierarchy



If we choose words that represent the general thinking of common vocabulary, there are three classes of items to be defined:

1. Data element: The smallest unit of data that provides for no further decomposition. For example, “date” consists of day, months and year. They hang together for all practical purpose.
2. Data structure: A group of data elements handled as a unit. For example, “phone” is a data structure consisting of four data elements ; Area code – exchange – number-extension- for example, 804-924-3423-236. “BOOK DETAILS” is a data structure consisting of the data elements author name, title, ISBN (International Standard Book Number), LOCN (Library of Congress Number), publisher’s name and quantity.
3. Data flows and data stores : Data flows are data structures in motion, whereas data stores are data structures at rest. A data store is a location where data structures are temporarily located. The three levels that make up the hierarchy of data are shown in Figure 8.

Describing Data Elements

The description of a data element should include the name, description, and an alias (synonym). For example :

AUTHOR – NAME - first	WHISKEY - name
- middle	- distiller
- last	- vintage
- alias	

The description should be a summary of the data element. It may include an example. We may also want to include whether or not the data element(s) has :

1. A different name : For example a PURCHASE ORDER may exist as PUR.ORDER, PURCHASE ORD., or P.O. We want to record all these in the data dictionary and include them under the PURCHASE ORDER definition and separately

with entries of their own. One example is 'P.O. alias of PURCHASE ORDER". Then we look up PURCHASE ORDER to find the details. It is an index.

2. The characteristics, such as a range of values or the frequency of use or both. A value is a code that represents a meaning. Here we have two types of data elements;
   a) Those that take a value within a range : for example, a payroll check amount between 41 and $10,000 is called a continuous value.
   b) Those that have a specific value; for example, departments in a firm may be coded 100 (accounting), 110 (personnel), etc. In a data dictionary, it is described as follows:
      100 means "Accounting Department"
      101 means "Accounts Receivable Section"
      102 means "Accounts Payable Section"
      108 means "General Ledger Section"

   In either type, values are codes that represent a meaning.
3. Control information such as the source, data of origin, users, or access authorization.
4. Physical location in terms of a record, a file or database.

Describing Data Structures:

We describe any data structure by specifying the name of each data structure and the elements it represents, provided they are defined elsewhere in the data dictionary. Some elements are mandatory, whereas others are optional. To illustrate, let us take "BOOK-DETAILS" from Figure 5. The data elements of this data structure are as follow:

The data structure BOOK – DETAILS is made up of five mandatory data elements and two optional ones.

Describing Data Flows and Data Stores:

The contents of a data flow may be described by the name(s) of the data structure(s) that passes along it. In our earlier example, BOOK-DETAILS expresses the content of the data flow that leads to process 4 (see figure 5). Additionally, we may specify the source of the data flow, the destination, and the volume (if any). Using the BOOK-ORDER EXAMPLE, data flows may be described as follow:

Data Flow	**Comments**
BOOK – DETAILS	From Newcomb Hall Bookstore (source)
AUTHOR – NAME	
TITLE OF BOOK	
EDITION	Recent Edition required
QUANTITY	Minimum 40 copies

A data stores is described by the data structures found in it and the data flows that feed it or are extracted from it. For example, the data store BOOKSTORE – ORDER is described by the following contents:

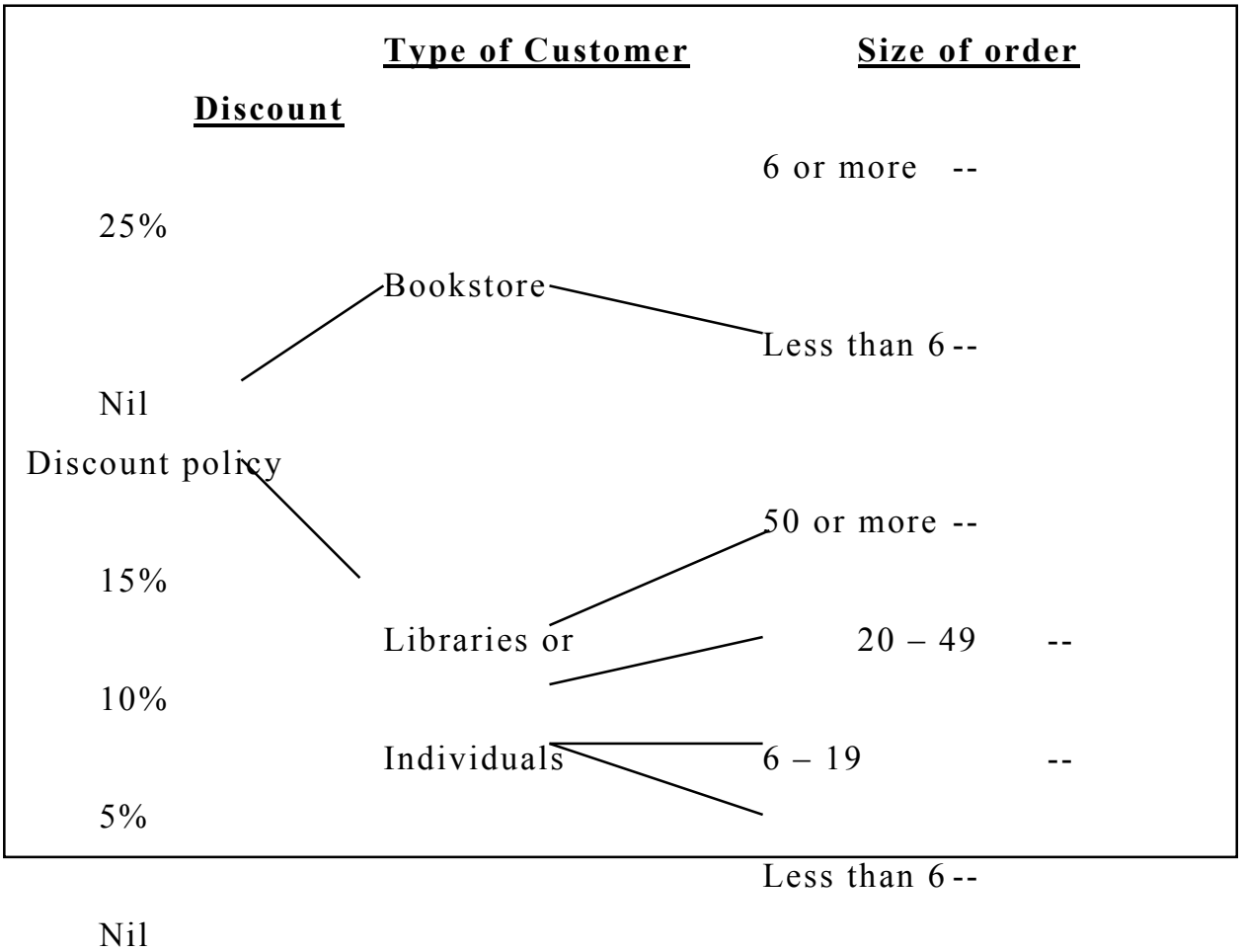
	Comments
ORDER	
ORDER – NUMBER	Data flow / data structure feeding data store
CUSTOMER – DETAILS	Content of data store
BOOK – DETAIL	Data flow/data structure extracted from store

Describing Processes

This step is the logical description. We want to specify the inputs and outputs for the process and summarize the logic of the system. In constructing a data dictionary, the analyst should consider the following points:

1. Each unique data flow in the DFD must have one data dictionary entry. There is also a data dictionary entry for each data store and process.

Figure 9 : Decision Tree – An example



Structured English borrows heavily from structured programming; it uses logical construction and imperative sentences designed to carry out instructions for action. Decisions are made through IF, THEN, ELSE and SO statements. The

structured English for our publisher's, discount policy is shown in Table 2.

We can actual make structured English more compact by using terms defined in the data dictionary. For example, the process ORDER may have the data element ORDER SIZE, which defines four values :

MINIMUM : 5 or fewer copies per book title

SMALL : 6 to 19 copies

MEDIUM : 20 to 49 copies

LARGE : 50 or more copies

Using these values, the structured English in Table 2 would read as shown in Table 3.

Table 2 : Structured English – An Example

COMPUTE DISCOUNT

Add up the number of copies per book title.

IF order is from bookstore

And-IF order is for 6 copies or more per book title

THEN: Discount is 25%

ELSE (order is for fewer than 6 copies per book title)

SO : no discount is allowed

ELSE (order is from libraries or individual customers)

So-IF order is for 50 copies or more per book title

Discount is 15%

ELSE IF order is for 20 to 49 copies per book title

Discount is 10%

ELSE IF order is for 6 to 19 copies per book title

Discount is 5%

ELSE (order is for less than 6 copies per book order)

SO no discount is allowed

Table 3 : Structured English – Using Data Dictionary Values

COMPUTE – DISCOUNT

Add up the number of copies per book title

IF order is from bookstore

And-IF	ORDER – SIZE is Small
THEN:	Discount is 25%
ELSE	ORDER-SIZE is MINIMUM
SO:	No discount is allowed
ELSE (order is from libraries or individual customers)	
So-IF	ORDER – SIZE IS LARGE
	Discount is 15%
ELSE IF	ORDER-SIZE is MEDIUM
	Discount is 10%
ELSE IF	
	ORDER-SIZE is SMALL
	Discount is 5%
ELSE	(ORDER-SIZE IS MINIMUM)
SO:	no discount is allowed

From these examples we see that when logic is written out in English sentences using capitalization and multilevel indentation, it is structured English. In this tool, the logic of processes of the system is expressed by using the capitalized key words IF, THEN, ELSE, and SO. Structures are indented to reflect the logical hierarchy. Sentences should also be clear, concise, and precise in working and meaning.

Importance of Data Dictionary

Data dictionary is an important tools for structured analysis as it offers following advantages –

1) It is a valuable reference for designing the system. It is used to build the database and write programs during design phase.

2) It assists in communicating meaning of different elements. Terms and procedures.

3) It facilitates analysis in determining additions and changes in the system.

4) It helps the analyst to record the details of each element and data structure.

5) It is used to locate errors in the system descriptions.

6) It is used a useful reference document curing implementation of the system.

3.4 Decision Tables:

A major drawback of a decision tree is the lack of information in this format to tell us what other combinations of conditions to test. This is where the decision table is useful. The decision table is a table to contingencies for defining a problem and the actions to be taken. It is a single representation of the relationship between conditions and actions. Figure 10 shows a decision table that represents our discount policy (Table 2 and Table 3).

A decision table consists of two parts: stub and entry. The stub part is divided into an upper quadrant called the condition stub and a lower quadrant called the action stub. The entry part is also divided into an upper quadrant, called the condition entry and a lower quadrant called the action entry. The four elements and their definitions are summarized in Table 3.

Figure : Decision Table – Discount Policy

Condition Stub

Condition Entry

		1	2	3	4	5	6
LIF (Condition)	Customer if Bookstore	Y	Y	N	N	N	N
	Order size 6 copies or more?	Y	N	N	N	N	N
	Customer Librarian or individual?			Y	T	Y	Y
	Order size 50 copies or more?			Y	N	N	N
	Order size 20-49 copies?				Y	N	N
	Order size 6 – 19 copies?					Y	N
THEN (action)	Allow 25% discount	X					
	Allow 15% discount			X			
	Allow 10% discount				X		
	Allow 5% discount					X	
	No discount allowed		X				X

Action Stub

Action Entry

Table 3. Elements and Definitions in a decision Table

Elements	Location	Definition
Condition Stub	Upper Left Quadrant	Sets forth in question form condition that may exist.
Action Stub	Lower left Quadrant	Outlines in narrative from the action to be taken to meet each condition.
Condition Entry	Upper right Quadrant	Provides answer to question asked in the conditions stub quadrant.
Action Entry	Lower Left Quadrant	Indicates the appropriate action resulting from the answer to the conditions in the condition entry quadrant.

Note in Figure, that the answers are represented by a Y to signify yes, an N to signify no, or a blank to show that the condition involved has not been tested. In the action entries quadrant, an X (or a check mark will do) indicates the response to the answer(s) entered in the condition entry quadrant. Furthermore, each column represents a decision or a rule. For example, rule 1, states :

IF customer is a book store and order size is 6 copies or more, THEN allow 25% discount.

So, according to the decision table, we have six decisions and therefore six rules. A look at the table provides each decision (answer) immediately. The following rules should be followed in constructing decision tables :

1. A decision should be given a name, shown in the top left of the table.
2. The logic of the decision table is independent of the sequence in which the condition rules are written, but the action takes place in the order in which the events occur.
3. Standarized language must be used consistently.
4. Duplication of terms or meanings should be eliminated, where possible.

3.5 Structured English:

Structured English uses narrative statements to describe a procedure. It uses three basis types of statements –

a) Sequence Structures:

They include a set of instructions that are carried out one after another and do not depend on any condition. Thus, for sequence structures instructions are written in the order, or sequence in which they are to be performed.

b) Decision Structures :

Decision structures are also known as Selection structures, is used for making decisions. They include one on more sets of instructions that are carried out depending upon one or more conditions. Decision structures are used for selecting the proper path out of two or more alternative paths in the program logic. They generally use the phrase IF THEN ELSE to carry out different actions.

c) Iteration Structures:

They include a set of instructions that are repeated until a particular condition occurs. They are used where one or more instructions may be executed several times depending on some condition. They generally use the phrase **DO WHILE... ENDDO** to repeat a set of instructions.

The examples of these three types of statements are given below

Sequential Structures :	Decision Structure:	Iteration Structure:

Accept employee code
Accept employee name
Accept other details
store data
	If Basic_Pay<= 1000
	HRA = 500
	Else
	If Basic_Pay<=3000
	HRA = 1000
	Else
	HRA = 1500
	End if
	End if
		Ans = "Y"
		Do while Ans = "Y"
		Accept employee code
		Accept employee name
		Accept other details
		Display "Continue(Y/N)?"
		Accept Ans
		End do

Examples of Three Types of Statements

Pros and Cons of Each Tool

Which tool is the best depends" on a number of factors : the nature and complexity of the problem, the number of actions resulting from the decisions, and the ease of use. In reviewing the benefits and limitations of each tool, we come to the following conclusions:

1. The primary strength of the DFQ is its ability to represent data flows. It may be used at high or low levels of analysis and provides good system documentation. However, the tool only weakly shows input and output detail. The user often finds it confusing, initially.
2. The data dictionary helps the analyst simplify the structure for meeting the data requirements of the system. It may be used at high or low levels of analysis, but it does not

provide functional details, and it is not acceptable to many non-technical users.

3. Structured English is best used when the problem requires sequences of actions with decisions.
4. Decision trees are used to verify logic and in problems that involve a few complex decisions resulting in a limited number of actions.
5. Decision trees and decision tables are best suited for dealing with complex branching routines such as calculating discounts or sales commissions or inventory control procedures.

Given the pros and cons of structured tools, the analyst should be trained in the use of various tools for analysis and design. He/she should use decision tables and structured English to get to the heart of complex problems. A decision table is perhaps the most useful toll for communicating problem details to the user.

The major contribution of structured analysis to the system development life cycle is producing a definable and measurable document – the structured specification. Other benefits include increased user involvement, improved communication between user and designer, reduction of total personnel time, and fewer "kinks" during detailed design and implementation. The only drawback is increased analyst and user time in the process. Overall the benefits outweigh the drawbacks, which make structured analysis tools viable alternatives in system development.

1.

Suggested Readings

1. Systems Analysis and Design (Hardcover)
   by Alan Dennis, Barbara Haley Wixom, Roberta M. Roth:

Course Technology; 4 edition (February 16, 2006Publisher: John Wiley & Sons; 3 edition (October 14, 2005)

2. Systems Analysis and Design Methods (Hardcover) by Jeffrey L Whitten, Lonnie D. Bentley Publisher: McGraw-Hill/Irwin; 7 edition (November 22, 2005)
3. Systems Analysis and Design (6th Edition) (Hardcover) by Kenneth E. Kendall, Julie E. Kendall Publisher: Prentice Hall; 6 edition (March 1, 2004)
4. Essentials of Systems Analysis and Design, Second Edition (Paperback) by Joseph S. Valacich, Joey F. George, Jeffrey A. Hoffer Publisher: Prentice Hall; 2 edition (March 3, 2003)

UNIT – III
LESSON NO. - 8
INPUT/OUTPUT FORM DESIGN

INPUT DESIGN

Inaccurate input data are the most common cause of errors in data processing. Errors entered by data entry operator can be controlled by input design. Input design is the process of converting user originated inputs to a computer based format. In the system design phase, the expanded data flow diagram identifies logical data flows, data stores, sources and destination. A systems flowchart specifies master files (data base), transaction tiles, and computer programs. Input data are collected and organized into groups of similar data. Once identified, appropriate input media are selected for processing.

Input Data

The goal of designing input data is to make data entry as easy, logical, and free from errors as possible. In entering data, operators need to know the following:

1. The allocated space for each field.
2. Field sequence, which must match that in the source document.
3. The format in which data fields are entered for example, filling out the date field is required through the edited format mm/dd/yy.

When we approach input data design, we design the source documents that capture the data and then elect the media used to enter them into the computer. Let us elaborate on each step.

Source Documents

Source data are captured initially on original paper or a source document. For example, a check written against an account is a source document. When it reaches the bank, it is encoded with special magnetic ink character recognition (MICR) so that it can be processed by a reader that is part of the information system of the bank. Therefore, source documents initiate a processing cycle as soon as they are entered into the system.

Source documents may be entered into the system from punch cards, from diskettes, or even directly through the keyboard. A source document may or may not be retained in the candidate system. Thus, each source document may be evaluated in terms of (1) Its continued use in the candidate system, (2) the extent of modification for the candidate system, and (3) replacement by an alternative source document.

A source document should be logical and easy to understand. Each area in the form should be clearly identified and should specify for the user what to write and where to write it. For example, a field as simple as date of birth may be written in four different ways:

1. 19 September 1935
2. Sept. 19, 1935
3. 9/19/35
4. 19/9/35 (European style)

Unless it is clear in a source document that two digits are a owed for the month, day, and year (MM/DD/YY), we could expect such combinations of responses.

In source documents where the user chooses from a list of operations efficient to direct the person to check the appropriate box than to enter a character.

Input Media and Devices

Source data are input into the system in a variety of ways. The following media and devices are suitable for operation:

1. *Punch cards* are either 80 or 96 columns wide. Data are arranged in a sequential and logical order. Operators use a keypunch to copy data from source documents onto cards. This means that the source document and card design must be considered simultaneously.

2. *Key to diskette* is modeled after the keypunch process. A diskette replaces the card and stores up to 325,000 characters of data equivalent to the data stored in 4,050 cards. Like cards, data on diskettes are stored in sequence and in batches. The approach to source document and diskette design is similar to that of the punch card. Data must be in sequence and logically cohesive.

3. *MICR* translates the special fonts printed in magnetic ink on checks into direct computer input.

4. *Mark sensing* readers automatically convert pencil marks in predator mined locations on a card to punched holes on the same card.

5. *Optical character recognition (OCR)* readers are similar to MICR i except that they recognize pencil, ink, or characters by their configuration (shape) rather than their magnetic pattern. They are often used in remote locations as free standing input preparation devices or direct input me to the system.

6. *Optical bar code readers* detect combination of marks that represent data. The most widely known system is the Universal Product Code (UPC), which codes retail items in stores. Automatic reading is a major breakthrough in speeding up customer service eliminating costly data input errors at the point of sale. It is virtually impossible for the sales clerk to enter incorrect merchandise information such as department and class type data.

Automatic tag reading is the ideal way to collect unit inventory information fast, accurately, and economically.

7. *Cathode ray tube (CRT)* screens are used for online data entry CRT screen display 20, 40, or 80 characters simultaneously on a television like screen. They show as many as 24 lines of data.

In addition to determining record media, the analyst must decide on method of input and the speed of capture and entry into the system, processing may lie batched (a group of records handled as a unit), online records processed directly), sequential (sorted records), or random (united) For example, magnetic tape may be suitable for batch sequential processing, whereas diskettes are ideal for online processing and random inquiries.

Online Data Entry

We live in the age of the microcomputer and at a time where more and more CRT screens arc used for online data entry. As terminal prices decline micro computers become more popular, entering data directly through the keyboard will become a way of life. The number of applications that rely on direct data entry is too long to list. Two examples are automated teller machines (ATMs) in banking and point of sale (POS) in retailing.

Online data entry makes use of a processor that accepts commands and data from the operator through a keyboard or a device such as a touch sensitive screen or voice input. The input received is analyzed by the processor. It is then accepted or rejected, or further input is requested. The request for input is in the form of a message displayed on the screen or by audio output.

Most keyboards have keys for alphabetic, numeric, as we as special functions. CRT screens display 24, 40, or 80 characters simultaneously or one line at a time, depending on the application and options offered by the vendor. Care must be taken that the hardware facilitates easy data entry into the system.

There are three major approaches for entering data into the computer menus, formatted forms, and prompts.

The Menu : A menu is a selection list that simplifies computer data access or entry. Instead of remembering what to enter, the user chooses from a list of options and types the option letter associated with it

A menu limits a user s choice of responses hut induces the chances error in data entry.

The Formatted Form. A formatted form is a preprinted form template that requests the user to enter data in appropriate locations. It is a fill-in-the blank type form. The form is flashed on the screen as a unit, curser is usually positioned at the first blank. After the user responds by filling in the appropriate information, the curser automatically moves to the next line , and so on until the form is completed. During this routine the user may move the curser up, down, right, or left to various locations for making charges in the response. Figure 10-5 is a safe deposit customer set-up form. The system requests information about the customer s name, address, renewal date, and so on. The user fills out the information on the dotted lines.

The Prompt (conversational mode). In prompt the system displays one inquiry at a time, asking the user for a response. For example, the following dialogue represents a prompt approach to data entry:

System : ENTER PASSWORD

User : A1260

System : ENTER FILENAME

User : Inventory

System : INPUT DATA NOW? Y/N

User : Y

Most systems edit the data entered by the user. For example, if the password exceeds Maximum number of digits or if the password is illegal, the system respond with a message like UNAUTHORIZED ENTRY or I EGAL NUMBER The user has three chances to enter the correct code, after which the system locks up. In banks automated teller machines (ATMs), if the customer entered his/her code wrong three times, the system retains the card and displays a message on the screen that the user should check with an officer during banking hours.

The prompt method also allows the user to key questions that determine the next response of the system. In our example INPUT DATA Y/N. if the response is Y, the system might display a record format entering data. Otherwise, it might automatically go back to the menu l different set of options. This method along with the menu and temp designed to improve the efficiency and accuracy of online data entry.

In each of the alternative approaches to data entry, the user s options are predefined. An inexperienced user is guided through complex functions by a formatted procedure. The main limitation with many of the available menus or prompts is that they require only one item to be entered at a tin rather than a string of data items simultaneously.

CRT Screen Design

Many online data entry devices are CRT screens that provide instant visual verification of input data and a means of prompting the operator. The operator can make any changes desired before the data go to the system for processing. A CRT screen is actually a display station that has a buffer (memory) for storing data. A common size display is 24 rows of 80 characters each or 1,920 character.

There are two approaches to designing data on CRT screens manual and software utility methods. The manual method uses a work sheet much like a print layout chart. The menu or data to be displayed are blocked out in the areas reserved on the chart and then they are incorporated into the system to formalize data entry. For example, we use dBASE II software commands (explained in Chapter 11) to display a menu on the screen. The first command in the partial program is interpreted by the system as follows: “Go to row 10 and column 10 on the screen and display (SAY) the statement typed between quotes.” The same applies to the next three commands. The command “WAIT TO A” tells the system to keep the menu on the screen until the operator types the option next to the word “WAITING”.

The main objective of screen display design is simplicity for accurate and quick data capture or entry. Other guidelines are:

1. Use the same format throughout the project.
2. Allow ample space for the data. Overcrowding causes eye strain and may tax the interest of the user.
3. Use easy-to-learn and consistent terms, such as “add”, “delete”, and “create”.
4. Provide help or tutorial for technical terms or procedures.

The second approach to designing screen layouts is through software utility, usually provided by the CRT vendor. For example, IBM provides a

OUTPUT DESIGN

Computer output is the most important and direct source of information to the user. Efficient, intelligible output design should improve the system’s relationships with the user and help in decision making. A major form of output is a hard copy from the printer. Printouts should be designed around the output requirements of the user. The output devices to consider depend on factors such as

compatibility of the device with the system, response time requirements, expected print quality, and number of copies needed. The following media devices are available for providing computer based output:

1. MICR readers
2. Line, matrix and daisy wheel printers.
3. Computer output Microfilm (COM)
4. CRT screen display
5. Graph plotters
6. Audio response

In addition to deciding on the output device, the systems analyst must consider the print format and the editing for the final printout Editing ranges from suppressing unwanted zeros to merging selected records to produce new figures. In either case, the task of output preparation is critical, requiring ski and ability to align user requirements with the capabilities of the system in operation

The standards for printed output suggest the following:

1. Give each output a specific name or title.
2. Provide a sample of the output layout, including areas where printing may appear and the location of each field.
3. State whether each output field is to include significant zeros spaces between fields, and alphabetic or any other data.
4. Specify the procedure for proving the accuracy of output data.

In online applications, information is displayed on the screen. The layout sheet for displayed output is similar to the layout chart used for designing input. Areas for displaying the information are blocked out, leaving the rest of the screen blank or for system status information. A owing the user to review sample screens can be extremely important because the user is the ultimate judge of the

quality of the output and, in turn, the success or failure) of the system. For example, the following shows editing output for a student birth date:

DISPIAY DATE OF BIRTH : (mm/dd/yy) 23/19/80

RESPONSE : MONTH EXCEEDS 12

SUGGESTS A RETRY : DATE OF BIRTH (mm/dd/yy)

FORMS DESIGN

We have learned that data provide the basis for information systems. Without data there is no system, but data must be provided in the right form for input and the information produced must be in a format acceptable to the user. In either case, it is still data the basic element of a printed form.

What is a Form

People read from forms, write on forms, and spend billions of hours handling forms and filing forms. The data the forms carry come from people, and the informational output of the system goes to people. So the form is a tool with a message, it is the physical carrier of data of information, can constitute authority for action. For example, a purchase order says BUY a customer s order says SHIP, and a paycheck says PAY TO THE ORDEM Each form is a request for action. It provides information for making decisions and improving operations.

With this in mind, it is hard to imagine a business operating wit using forms. They arc the vehicles for most communications and the blue print for many activities. As important as a printed form is, however, majority of forms are designed by poorly trained people. People are puzzled by confusing forms they ask for directions on how to read them and he fill them out. When a form is poorly designed, it is a poor (and cost administrative tool.

Classification of Forms

A printed form is generally classified by what it does in the system. Then are three primary classifications action, memory, and report forms. An action form requests the user to do something get action. (Examples are purchase orders and shop orders.) A memory form is a record of historical data that remains in a file, is used for reference, and serves as control on key details. (Examples are inventory records, purchase records, and bond registers.) A report form guides supervisors and other administrators in their activities. It provides data on a project or a job. (Examples are profit and loss statements and sales analysis reports.) The characteristics and examples of these forms are as under:

Three Classes of Forms ─ A Summary

Class	**Characteristics**		**Examples**
Action	1. 2. 3.	Orders, instructs, authorizes Achieves results Goes from one place (person) to another	Application form Purchase order Sales slip Shop order Time card
Memory	1. 2. 3. 4.	Represents historical data Data genera y used for reference Stationary and remains in one place, usually in a file Serves as control on certain details	Bond register Inventory record Journal sheet Purchase record Stock ledger
Report	1. 2. 3. 4.	Summary picture of a project Provides information about job or details that need attention Used by a manager with authority to effect change Used as a basis for decision making	Balance sheet Operating statement Profit and loss statement Sales analysis Trial balance

Requirements of Forms Design

Forms design follows analyzing forms, evaluating present documents, and creating new or improved forms. Bear in mind that detailed analysis occurs only after the problem definition stage and the beginning of designing the candidate system. Since the purpose of a form is to communicate effectively through forms design, there are several major requirements:

1. *Identification and wording.* The form title must clearly identify its purpose. Columns and rows should be labeled to avoid confusion. The form should also be identified by firm name or code number to make it easy to reorder.

2. *Maximum readability and use.* The form must be easy to use and fill out. It should be legible, intelligible, and uncomplicated. Ample writing space must be provided for inserting data. This means analyzing for adequate space and balancing the overall forms layout, administration, and use.

3. *Physical factors.* The form s composition, color, layout (margins, space, etc.), and paper stock should lend themselves to easy reading. Pages should be numbered when multipage reports are being generated for the user.

4. *Order of data items.* The data requested should reflect a logical sequence. Related data should be in adjacent positions. Data copied from source documents should be in the same sequence on both forms (see Figure 10-9). Much of this design takes place in the forms analysis phase.

5. *Ease of data entry.* If used for data entry, the form should have field positions indicated under each column of data (see Figure 10-9) and should have some indication of where decimal points are (use broken vertical lines).

6. *Size and arrangement.* The form must be easily stored and filed. It should provide for signatures. Important items must be in a prominent location on the form.

7. *Use of instructions.* The instructions that accompany a form should clearly show how it is used and handled.

8. *Efficiency considerations.* The form must be cost effective. This means eliminating unnecessary data and facilitating reading lines across the form. To illustrate, if a poorly designed form causes 10 supervisors to waste 30 seconds each, then 5 minutes are lost because of the form, ff the firm uses 10,000 of these forms per year, then 833 hours of lost time could have been saved by a better forms design.

9. *Type of report.* Forms design should also consider whether the content is executive summary, intermediate managerial information, or supporting data. The user requirements for each type often determine the final form design.

Carbon Paper as a Form Copier

There are many ways of duplicating forms but none is as handy and versatile as carbon paper. There are two primary types of carbon, classified by the action they encounter:

1. *Glide action* carbon inserted between a set of forms allows the glide action of the pencil (or ballpoint) to transfer dye to the surface of the sheet beneath.

2. *Hammer action* carbon is used in typewriters and line printers of computers. The hammer action of the key(s) transfers the carbon coating to the sheet beneath.

Various methods of transferring impressions between copies are also used:

1. *One time carbon.* Made of inexpensive Kraftex paper, it is interleaved between two sheets in the form, used once, and

then thrown away. It is the most cost effective (also the messiest method for multipart forms.

2. *Carbon backed paper.* The back of each form copy is coated with carbon, which transfers data to the copy beneath.

3. *NCR (no carbon required) paper.* The top sheet is chemically treated with invisible dye, which allows impressions to be transferred to the next lower copy. It is the cleanest method of copying but also the costliest. Erasing removes the coating permanently.

Selected data are deleted from printing on certain copies by using split carbons or short carbons or by printing a random design in the area where the data will be printed. The random design blurs out the readability of the printed data. Generally, one time carbon is preferred when a small number of copies is required. If carbon is unacceptable, NCR paper has recommended. When selected data are restricted to specific copies, split carbons are used.

Types of Forms

Forms are classified into several categories flat forms, unit-set/snapout forms, continuous strip fanfold forms, NCR paper, and preprinted forms. These types are described briefly.

Flat Forms

A flat form is single copy form prepared manually or by a machine and printed on any grade of paper. For additional copies of the original, carbon paper is inserted between copies. It is the easiest form to design, print, and reproduce it has a low volume use and it is the least expensive. Often a pad of the flat forms is printed identical to the original copy of a unit set.

Unit-Set/Snapout Forms

These forms have an original copy and several copies with one time carbon paper interleaved between them. The set is glued into a

unit (thus, unit set) for easy handling. The carbon paper is approximately 3/8 inch shorter than the copies. The copies are perforated at the glue margin for tearing out, although the carbon is not perforated. Because of the perforation and the shorter carbon, the forms can be easily snapped out (thus, the name snapout form) after completion.

Continuous Strip/Faniold Forms

These are multiple unit forms joined together in a continuous strip with perforations between each pair of forms. One-time carbon is interleaved between copies, which are stacked in a fanfold arrangement. The pin feed holes punched in both margins for mounting the forms onto the sprocket wheels of the printer The device eliminates individual insertion of forms. The fanfold is the least expensive construction for large volume use. Computer printouts are invariably produced on them they are virtually part of systems design.

NCR (no carbon required) Paper

Several copies can be made by pressing a chemical undercoating on the top sheet into a claylike coating on the top of the second sheet. The writing (or printing) pressure forms an image by the coating material. The same process applies to the back of the second sheet for producing a carbon copy on the face of the succeeding sheet, and so on.

NCR paper Jus many applications in salesbooks, checkbooks, inventory tickets, and deposit slips. It offers cleaner, clearer, and longer lasting copies than carbon-interleaved forms. No carbon means no smears or smudges.

One problem is the sensitivity of the chemical It shows every unintended scratch. Other disadvantages are difficulty with erasures and high cost. NCR paper costs as much as 25 percent more than the

carbon interleaved forms. Considering the labor savings of the NCR process, however, cost may be we justified in the long run.

Layout Considerations

When a form is designed, a list is prepared of all the items to be included on the form and the maximum space to be reserved. The list should be checked by the form user to make sure it has the required details.

Form Title and Number

The first consideration in forms design is a brief, descriptive title that tells what the form is and what it does. Since we read from left to right and from top to bottom, the upper left comer of the form is an appropriate place for a title. On forms that go outside the organization, the title is placed in the center at the top of the form.

Long titles with vague words should be avoided. Good titles often are no longer than two words.

A form number identifies the form, serves as a reference, and provides a control check for the supply room. Since the title and number a re parts of the form identification, they should be placed together say, in the upper left comer of the form. For an oversized form, the title is positioned in the center in bold type. In other situations where the upper left corner is used, the lower left corner is an alternative location.

Data Classification and Zoning

Have you ever filled out a form where you had to “jump around”? Many forms have this design weakness. The solution is simple: List all the items that must go on the form and classify them into logical groupings. All other items are listed under a general classification. For example, in a purchase order, several items fall into a group ca ed shipping instructions. They include SHIP TO, SHIP FROM, and SHIP VTA.

After the items are classified into a logical sequence by group, the next consideration is placing the data groups in appropriate areas (zones). To summarize:

1. A form is divided into zones each zone represents a similar group of information.
2. The zones are organized in a logical flow based on the upper left corner (ULC) method. As shown in Figure 10-16, a form should be designed to be read or filled out in the same way we read or write in English (left to right and top to bottom).
3. When more than one form is involved, the sequence of data in related forms should follow the same flow.

Rules and Captions

In designing forms, use rules (lines) to guide the human eye to read and write data groups. In this respect, printed rules aid in zoning a form. A caption is similar to a column heading. It specifies what information to write in the space provided. Rules and captions go together: Rule, guide and separate, whereas captions guide and instruct.

Since a caption is used to guide, one or two different sizes of captions are usually used. A caption should not be set in such bold type that it barks at the form user.

Light, single hairline rules should be used need for separating parts of the form in that case, be used. A column heading is a caption used to refer to more than one rule or box on a form.

To summarize, a form is designed with a combination of rules captions. Rules can also be used to make boxes in which the user pi data. The caption tells the user what information goes in a particular position.

Box Design

Whenever possible, it is advisable to design the form using the box-style, with captions in the upper left comer. The box design gets

Form Caption Abbreviations

Caption Word	Abbreviation	Caption Word	Abbreviation
Account	Acct	Hours	Hrs
Amount	Ami	Manager	Mgr
Average	Avg	Merchandise	Mdse
Balance	Bat	Paid	Pd
Check	Ck	Quantity	Quan
Department	Dept	Received	Reed
Dis . iunt	Disc	Signature	Sig
Each	Ea	Weight	wt
Frright	Fit	Zip code	Zip

captions up out of the way and reduces the form size by 25 to 40 percent. It also makes the data entry uninterrupted from left to right. The traditional design is acceptable for a handwritten form, but it can be tricky to position the captions on the typewriter.

Spacing Requirements

If you pick 20 printed forms at random, you will find a great variety of spacing on them. Most forms seem to be spaced haphazardly. The method of preparing a form tells whether to allow for handwritten, printed entries, or both. In either case, there must be sufficient space to allow for data capture. A standard is needed.

A commonly used standard, called 3/5 spacing. The 3 refers to the number of lines per vertical inch, while the 5 refers to the number of characters that fit in one horizontal inch. This approach it related to spacing for clerks 18 characters per inch or cpi), workers (5 and printers (10/12 cpi).

There are times when a certain amount of space must have a minimum number of lines. One way of determining lines is with the diagonal spacing method. A 4 inch space is divided into nine writing lines by placing a ruler diagonally across the space so that the 4½ inch mark, (equaling nine half inch spaces) spans the 4 inch area. In this case, ½ inch multiples are used. A one inch, multiple can be obtained simply by making a sharper diagonal slant of the ruler.

In columnar spacing, the column width is determined by the amount of data in the column and how data are recorded. The 3/5 rule should be adequate to determine the columnar spacing required on most forms Column headings should be written horizontally whenever possible.

Ballot Box and Check off Designs

Using ballot or check off boxes for questions that can be answered by yes, or no can greatly reduce the amount of required writing. The user indicates a preference simply by checking off the desired box or placing an X in the appropriate space Figure 10-24 illustrates both designs.

Form Instructions

A well-designed form with clearly stated captions should be self-in-structing. In a recent consulting job, an eight-page procedure included two pages telling how to fill out the printed forms. A sample of the inst is as follows:

Date : Fill in the current date.

Name : Print legal name in full.

Description : Give title of each part.

Signature : Your supervisor must sign here.

The first form had 29 captions. The procedure listed the caption explained the information required under each. Much of this work have been eliminated if the captions were self explanatory.

Forms such as application blanks that are filled out once should be instructing. Other forms (e.g. purchase orders) that are processed repeatedly by several people should be designed for easy writing, typing, soiling. A form becomes self instructing by means of clearly stated caption and brief, but specific, procedural instructions. The following examples illustrate these points.

The procedural instructions on the form should be self explanatory example, Enclose your stub with your payment".

Instructions are placed on the cover of padded forms or in the stub area of snap out forms. Some forms have instructions on the back. A notation on the front upper left comer of the page tells the user where to find the instructions.

Paper Selection

Forms may be printed on paper of different colors, grades, and weights. Colored paper or colored printing on white paper is used to distinguish among copies and facilitate sorting copies. Common color preferences are listed in the table.

Order of Copy	**Color**
First	White
Second	Yellow
Third	Pink
Fourth	Blue
Fifth	Buff (or goldenrod)

Paper weight is based on a ream of 500 sheets that are 17 by 22 inches it ramges from 4 pounds to 220 pounds. Cutting the 500 arts into quarters results in the standard size of a typewriter page 8½ by 11 inches.

There are three major factors to consider in paper selection : appearance, longevity, and handling. The form designer needs to know (1) the number of times the form will be handled (daily, weekly, etc.), (2) the 1 Blount of folding it will receive, and (3) the extent of exposure to the environment.

Paper is generally classified as onionskin, bond, duplicator, ledger, index, and card stock. Its thickness is expressed in pound weight. Onionskin paper (9 pound weight) is used for inner copies of multiple part sets. Bond paper is usually rag paper that has the best feel and quality, depending on the rag content (25, 50, or 100 percent). Duplicator paper (16 20 pound weight) is used for duplicating and xeroxing machines. Ledger paper (28-32 pound weight) is used for checks, accounting records, and permanent ledger cards. Index paper (more than 72 pound weight) is strictly for printing cards. Card stock is the heaviest paper, although it has a lower grade than the other types mentioned. It comes in various weights, ranging from 90 to 140 pounds. The 90 pound weight is used for durable records. The 140 pound weight is strictly heavyweight card stock.

Cost Considerations

Various cost factors go into the final decision to produce a form. Costs consist of both one time (flat) and running costs. Flat charges center around the preparation of the system used to create the first copy. Charges such as the cost of paper, ink, machine, and labor are a running charges. One way of reducing costs is to order two up or side by side forms attached by a perforated line. Other cost reducing alternatives are:

1. Using standard size and weight paper.
2. Ordering in larger quantities at a discount.
3. Discouraging the use of unnecessary color.
4. Using standard locations for key captions and form title.

Forms Control

The first step in forms control is to determine whether a form is necessary. Managing the hundreds of forms in a typical organization requires a control program. Forms control is a procedure for (1) providing imp and effective forms, (2) reducing printing costs, and (31 securing adequate stock at a times.

The first step in a procedure for forms control is to collect, group, ii stock, and control the forms of the organization. Each form is identified and classified by the function it performs and whether it is a flat form, a snap out form, or something else. Once classified, a form is evaluated by the data it requires, where it is used, and how much it overlaps with other forms. The object is to get rid of unnecessary forms and improve those forms that are necessary.

Before launching a forms control program, the designer needs to consider several questions:

1. Who will be responsible for improving forms design ?
2. Should forms be produced in house or assigned to an outside printer?
3. What quantity should be printed What is the break even point on printing forms?
4. How much lead time is required to replenish forms?
5. How will one handle reorders? Who will initiate them? In what way?
6. How will obsolete forms be handled?
7. What should be the life of the form?

8. Where and how should the form be stored?

If questions of this nature are not addressed in advance, the organization is probably not ready to launch a forms control program.

Review Questions

1. What is the goal of input design? Output design?
2. If you were asked to adopt a method for tagging merchandise of a retail store, what input medium would you choose? Why?

UNIT III
LESSON NO. 9
TESTING

System testing is an expensive but critical process that can take as much as 50 percent of the budget for program development. The common view of testing held by users is that it is performed to prove that there are no errors in a program. However, this is virtually impossible, since analysts cannot prove software is free and clear of errors.

Therefore, the most useful and practical approach is with the understanding that testing is the process of executing a program with explicit intention of finding errors that is, making the program fail. The tester, who may be an analyst, programmer, or specialist trained in software testing, is actually trying to make the program fail. A successful test, then, is one that finds an error.

Analysts know that an effective testing program does not guarantee system reliability. Reliability is a design issue. Therefore, reliability must be designed into the system. Developers cannot test for it.

Verification and validation

Like testing, verification is also intended to find error. Executing a program in a simulated environment performs it. Validation refers to the process of using software in a live environment on order to find errors.

The modules are in increasing detail. Depending on the complexity of the system, three to five levels of modules are typical.

When commercial systems are developed with the explicit intention of distributing them to dealers for sale or marketing them through company owned field offices they first go through verification, some-times called alpha testing. The feed back from the

validation phase generally produces changes in the software to deal with errors and failures that are uncovered.

Then a set of user sites is selected that puts the system into use on a live basis. These beta test sites use the system in day- to - day activities; they process live transactions and produce normal system output. The system is live in very sense of the word, except that the users are aware they are using a system that can fail. But the transactions that are entered and the persons using the system are real.

Validation many continue for several months. During the course of validating the system, failure may occur and the software will be changed.

Continued use may produce additional failure and the need for still more change.

Certification

Software certification is an endorsement of the the program, an issue that is rising in importance for information systems applications. There is an increasing dependence on the purchase or lease of commercial software rather than on its in-house development. However, before analysts are willing to approve the acquisition of a package, they often require certification of the software by the developer or an unbiased third party.

For example, selected accounting firms are now certifying that a software package in fact does what the vendor claims it does and in a proper manner. To so certify the software, the agency appoints a team of specialists who carefully examine the documentation for the system to determine what the vendor claims the system does and how it is accomplished. Then they test the software against those claims. If no serious discrepancies of failures are encountered, they will certify that the software does what the documentation claims. They do not, however, certify that the software is the right package for a

certain organization. That responsibility remains with the organization and its team of analysts.

Testing Plans

The philosophy behind testing is to find errors. Test cases are devised with this purpose in mind. A test case is a set of data that the system will process as normal input. However, the data are created with the express intend of determining whether the system will process them correctly. For example, test cases for inventory handling should include situations in which the quantities to be withdrawn from inventory exceed, equal, and are less than the actual quantities on hand. Each test case in designed with the intent of finding errors in way the system will process it.

Code Testing

The code testing strategy examines the logic of the program. To follow this testing method the analyst develops test cases that result in executing every instruction in the program module; that is, every path through the program is tested. A path is a specific combination of conditions that is handled by the program. For example, in the accounting systems example one path through the system is to change the account balances. The correct request is submitted, then the proper passwords, data, and command entries.

On the surface, code testing seems to be an ideal method for testing software. However, the rationale that all software errors can be uncovered by checking every path in a program is faulty. First of all, in even moderately large programs of the size used in typical business situations, it is virtually impossible to do exhaustive testing of this nature. Financial considerations and time limitations alone will usually preclude executing every path through a program, since there may be several thousand.

However, even if code testing can be performed in its entirety, it does not guarantee against software failures. This testing does not

indicate whether the code meets its specifications nor does it determine whether all aspects are even implemented. Code testing also does not check the range of data that the program will accept, even though, when software failures secure in actual use, it is frequently because users submitted data outside expected ranges.

Specification Testing

To perform specification testing, the analyst examines the specifications stating what the program should do and how it should perform under various conditions. Then test cases are developed for each condition or combination of conditions and submitted for processing. By examining the results, the analyst can determine whether the program performs according to its specified requirements.

This strategy treats the program as if it were a black box: the analyst does not look into the program to study the code and is not concerned about whether every instruction or path through the program is tested. In that sense, specification testing is not complete testing. However, the assumption is that, if the program meets the specifications, it will not fail.

Neither code nor specification testing strategy is ideal. However, specification testing is a more efficient strategy, since it focuses on the way software is expected to be used. It also shows once again how important the specifications developed by the analysts are throughout the entire systems development process.

Managing Testing Practices

Regardless of which strategy the analyst follows, there are preferred practices to ensure that the testing in useful. The levels of tests and types of test data, combined with testing libraries, are important aspects of the actual process.

Levels of Test

Systems are not designed as entire systems nor are they tested as single systems. The analyst must perform both unit and integration testing.

Unit Testing

In unit testing the analyst test the programs making up a system. (For this reason unit testing is sometimes called program testing.) The software units in a system are the modules and routines that are assembled and integrated to perform a specific function. In a large system, many modules at different levels are needed.

Unit testing focuses first on the modules, independently of one another, to locate errors. This enables the tester to detect errors in coding and logic that are contained within that module alone. Those resulting form the interaction between modules are initially avoided.

For example, a hotel information system consists of modules to handle reservations; guest check-in and checkout; restaurant, room service, and miscellaneous charges convention activities; and accounts receivable billing. For each, it provides the ability to enter, change or retrieve data and respond to inquiries or print reports.

The test cases needed for unit testing should exercise each condition and option. For example, test cases are needed to determine how the system handles attempts to check-in guests who do and do not have reservations, as well as those instances involving changing the name on the reservation when a person other than the one listed arrives. Also needed are test cases for the checkout situations of paying the exact amount of the bill, only part of the bill, and more than the amount shown. Even checking out without making any payment at all must be included in a test case.

If the module receives input or generates output, test cases are also needed to test the range of values expected, including both valid and invalid data. What will happen in the hotel checkout example if a guest wishes to make a payment of Rs. 1, 00,000 for an upcoming

convention? Are the payments and printing modules designed to handle this amount? Testing for this question quickly detects existing errors.

If the module is designed to perform iterations, with specific processes contained within a loop, it is advisable to execute each boundary condition: iteration, literation through the loop, and the maximum number of iterations through the loop. Of course, it is always important to examine the result of testing, but special attention should be given to the conditions. Analysts too often make the mistake of assuming that case of 0 iteration will automatically be handled properly.

Unit testing can be performed from the bottom up, starting with the smallest and lowest-level modules and proceeding one at a time. For each module in bottom-up testing, a short program (called a driver program because in drives or runs the module) executes the module and provides the needed data, so that the module is asked to perform the way it will when embedded within the larger system. When bottom-level modules are tested, attention turns to those on the next level that use the lower-level ones. They are tested individually and then linked with the previously examined lower-level modules.

Top-down testing, as the name implies, begins with the upper-level modules. However since the detailed activities usually performed in lower-level routines are not provided (because those routines are not being tested), stubs are written. A stub is a module shell that can be called by the upper-level module and that, when reached properly, will return a message to the calling module, indicating that proper interaction occurred. No attempt is made to verify the correctness of the lower-level module.

Integration testing

Integration testing does not test the software but rather the integration of each module in the system. It also tests to find discrepancies between the system and its original objective current specifications and systems documentation. The primary concern is the compatibility of individual modules. Analysts are trying to find areas where modules have been designed with different specifications for data length, type, and data element name. For example, one module may expect the data item for customer identification number to be a numeric field, while other modules expect it to be a character data item. The system itself may not report this as an error, but the output may show unexpected results. If a record created and stored in one module, using the identification number as a numeric field, is later sought on retrieval with the expectation that it will be a character field, the field will not be recognized and the message required recorded not received will be displayed.

Integration testing must also verify that the file sizes are adequate and that indices have been built properly. Sorting and rendering procedures assumed to the present into lower-level modules must be tested at the systems need to that they in fact exist and achieve the results modules expect.

There are other tests that are in special category, since they do not form on the normal coming of the system. Six tests are essential.

1. Bank Online system

There are critical times in many systems, particularly online systems. For example, in a barking system, analysts want to know what will happen if all teller sign on at their terminals at the same time before the start of the business day. Will the system handle them one at a time before the start of the will it attempt to handle all of the at once and be so confused that it “locks up” and must be restarted, or will terminal addresses be lost? The only sure way to find out is to test for it. The same situations can arise when tellers’

sing out during lunch periods and at the end of the day, so testing is looking at real situations.

2. Storage Testing

Analysts specify a capacity for the system when it is designed and constructed. Capacities are measured in terms of the number of records that a disk will handle or a file can contain. These capacities are linked to disk space and the size of indices, record keys, and so on. But they too must be tested. If the cementation for a new system to be run on a microcomputer claims that a disk up to 10,000 records, each 393 types long the claim must be verified before implementation.

Storage testing often requires entering data until the capacity is reached. Comparing the actual and claimed capacities will verify the accuracy of the documentation on the one hand and allow a judgment about actual capacity at the same time. Many, many systems are never tested in this way. Users find out too late that claims made during installation are not true: there is, not enough storage capacity for transaction and master file records.

3. Performance Time Testing

When analysts are developing a design, their concerns are more on reports inputs, files; and processing sequences than on performance time, although this changes with experience. During simple unit and integration testing, relatively small sets of data are used to find errors or cause failures. Therefore, users frequently find out slow or fast the response time of the system is only after it has been installed and loaded up with data. That may be too late. Systems are rarely too fast for users.

Performance time testing is conducted prior to implementation to determine how long it takes to receive a response to an inquiry, make a backup copy of a file, or send a transmission and receive a response. It also includes test runs to time indexing or resorting of

large files of the size the system will have during a typical run or to prepare a report.

A system that runs well with only a handful of test transactions may be unacceptably slow when full loaded. And the time to know about this is prior to implementation, when adjustment can be more easily made. Once files are fully loaded and the user is relying on the system for daily activities, it is difficult to pull it back and being large-scale changes. The user needs the system and the analyst will not want to risk the loss of live data.

4. Recovery Testing

Analysts must always assume that the system will fail and data will be damaged or lost. Even though plans and procedures are written to cover these situations, they also must be tested. By creating a failure or data loss event where the users are forced to reload and recover forma backup copy, analysts can readily determine whether recovery procedures are adequate. The best-designed plans usually are adjusted or augmented after this test.

5. Procedure Testing

Documentation and run manuals tell the user how to perform certain functions are tested quite easily by asking the user to follow them exactly through a serried of event. It is surprising how not including instructions about when to depress the enter key, about removing diskettes before powering down, or what to do when the paper-out light on the printer lights up can raise questions.

There is, of course, no substitute for a well- designed-set of procedure manuals. Analysts concentrate on the major and critical details of systems design and include them in the documentation. They also pay attention to the little details, when designing the system. But often descriptions of the detail do not get into the documentation. This type of testing not only shows where they are

needed but also where they are wrong, that is, where actions suggested· in the documentation do not match those that must actually be taken to make the system.

6. Human factors Testing

What do users do if, after submitting a transaction through a terminal, the screen goes blank while the data are being processed? They may not take the actions the analyst wants or expects, instead responding in. unusual ways: they may depress the send key several times, turn the power switch on the terminal off and back on, unplug it' and replug it, or beat on the terminal. Obliviously, they will do just about anything if the analyst has not given them some massage on the screen to indicate, that their request has been received, that. it is being processed, and that there will be a short delay This is what human factors testing is all about finding answers to questions about how people will react to the system in ways not anticipated. And as general rule, as strange as the above actions may sound, the people are right; they are taking actions that are normal under the circumstances.

It is the responsibility of the analyst to anticipate questions that will arise in the minds of the users as they interact with the system. If a screen will go blank during transaction processing, the analyst should make sure that it displays a message informing the user .that processing is occurring. Even that not enough if the delay will be more than a second or two. For processing that will take long periods, the analyst should have the screen give the user a message telling approximately how long it will take and providing an option to cancer the request. The user may decide to have that one - hour Job run some other time, when the system is not so busy.

These simple testing questions are of monumental importance an extremely helpful in finding flaw that can cause the system to fail. Some analysts will find these flaws the hard way through and

questions. It is difficult to forget the system that was damaged because a user hanged on the terminal when data were submitted and accepted by the system without displaying a response. But, following the godliness above, the analysts can avoid those situations.

Designing Test Data

There are two very different sources of test data, live and artificial. Both have district advantage and disadvantages for the tester.

Using Live Test Data

Live test data are those that are actually extracted from organization files. After a system partially constructed, programmers or analysts often ask users to key in a set of data from their normal activities. For example, in a general ledge accounting system, they may ask someone from the accounting staff to enter the chart of account numbers and a set of account balances, along with transactions affecting those accounts. Then the system person uses this data as a way to partially test the system. In other instances, programmers or analysts extract a set of live data from the files and have them entered themselves.

It is difficult to obtain live data in sufficient to conduct extensive testing and, although it is realistic data that will show how the system will perform for the typical processing requirements assuming that the live data entered are in fact typical, such data generally will not test all the combinations or formats that can enter the system. The bias toward typical values then does not provide a true systems test and in fact ignores the cases most likely to cause systems failure.

Using Artificial Test Data

Artificial test data are created solely for test purposes, since they can be generated to test all combinations of formats and values. In other words, the artificial data, which can quickly be prepared by

a data-generating utility program in the information systems department, make possible the testing of all logic and control paths through the program.

The most effective test programs use artificial test data generated by persons other than those who wrote the programs. Often, an independent team of tester formulates a testing plan, using the systems specifications.

Testing Libraries

To assure that all systems are properly tested, many organizations establish test libraries. A testing library is a set of data developed to thoroughly test a system of programs. It is stored in machine-readable form, usually on magnetic disk, and is used by all persons who are involved with a particular system.

For example, a large inventory system consists, of hundreds of computer programs. All share common data and file formats. Each will also process similar transaction and will sometimes update records and other times retrieve data to respond to inquiries or reports and documents. Because these programs are interdependent and process-related transaction, it makes sense to use a common set of data to test each program.

Test libraries are not just for initial testing. As the system evolves and programs are modified and maintained, they must be requested. The testing library should be maintained throughout the life of the system so that, as each change is made, reliable data are again available to test the system.

System Controls

A well-designed system should have controls to ensure proper operation and routine auditing. A candidate systems failure often results from lack of emphasis on data control. Therefore, standards of accuracy, consistency and maintainability must be specified to eliminate errors and control for fraud.

A system design introduces new control elements and changes the control procedures. New controls in the form of relational comparison are designed to defect and check errors that rise form the use of the system. In a manual system, internal control depends on human judgment, personal care and division of labor. In a computer based system the number of persons involved is considerably reduced. In designing a new system the designer should specify the location of error control points and evaluate them on the basis of error frequency, cost and timing of error detection. By identifying points where potentials errors may occur, designers can create control procedures for handling errors immediately.

Processing controls

Several methods have been devised to control processing activities:

1. Data record may be combined into small groups to control totals. It in batch processing, error is encountered the batch may be held and reviewed to correct the error.
2. Completeness check ensures that all fields in a record are present and are read in the proper sequence. In a multiple record check, the program verifies the self- checking number of the records that make up the transaction. If an error is detected, the entire group of records is rejected.
3. Consistency check refers to the relevance of one type of data to another. Data being accepted through various means need to be checked for its uniformity. All critical paths need to be checked for its proper path selection.
4. Reasonableness check evaluates a transaction against a standard or maximum / minimum value to determine its validity. For example an employee may not have age less than 21 and not more than 60 years.

5. Sequence check verifies that data records are in sequence prior to processing. Duplicate records needs to be checked.

Audit Trails

An important function of system controls is providing for an audit trail. An audit trail is a routine designed to allow the analyst, user or auditor to verify a process or an area in the new system.

Definition of Audit trail

A feature of data of systems that allows for the study of data as processed form step to step, an auditor may then trace all transactions that affect an account.

In a manual system, the audit trail includes journals r, ledgers and other documents used by auditor to trace transactions. In a computerized system, record content and format frequently make it difficult to trace a transaction completely. Some reasons are the following:

1. Files stored on the tape or disk can be read only by a computer, which limits to auditing function. A data dump is possible, though, to compare the data against a data map.
2. Direct data entry eliminates the physical documentation for an audit programme.
3. Data processing activites are difficult to observe, since they take place within the computer system.

For the audit trail to show its impact a detailed file of the transactions need to be maintained. During evaluation of a system following steps should be considered.

1. Define the control objectives as separate design and test requirement. Input preparation and transmission by the user are important control areas that are viewed with an emphasis on audit trails adequate documentation during testing.

2. Examine budget costs to the whether system testing in within the limits.
3. Review specifications. The auditor should evaluate program acceptance test specifications and assist the programmer in developing test standards, levels of testing and actual test conditions.

It is the auditor's responsibility to build controls into candidate systems to ensure reliability, integrity and confidence of the users at all levels. The auditor should be called in during design as well as testing so that suggestion can be considered before implementation. Including the auditor in the system development team makes it easy for monitoring testing procedures and considers the acceptance of new controls to replace those changed by new design.

UNIT III

LESSON NO. 10

IMPLEMENTATION AND MAINTENANCE

Putting a new system into operation is usually complicated by the fact that there is an older system already in operation. The analyst has to deal with changing from something familiar to something new and different, while also attending to the mechanics of implementation. Sicne the concern for simultaneous conversion and implementation is usual. New system brings in new equipment. It may represent a change from manual to automated operation or a change in the level of available machine capacity. During implementation, planning plays a decisive factor in determing the ultimate success or failure of system. Due attention should be paid to:

1. Assigning system personnel.
2. Structuring user relationship.
3. Preparing for new equipment.
4. Training user personnel.

1. Assignment of Systems Personnel:

Assign people to the implementation who demonstrate the ability in dealing with the unique problem situations associated with the process.

2. Structuring user Relationships:

Plan for periodic meeting between user and system personnel for the duration of the implementation, to discuss problems being faced. Also there should be provisions to meet when the need arises. Certainly waiting for the meeting in critical problems is not a reasonable approach. Also if people meet only during crisis, they cannot expect a very positive encounter.

3. Preparing for New Equipment:

New equipment means more complexity. For new equipment additional areas of concerns are to be taken care of: -

1. Structuring a relationship with the equipment vendor.
2. Preparing a physical site for installation and use of new equipment.
3. Installation of new equipment and removing old equipment.
4. Training personnel to use the new equipment.

4. **Training of user Personnel: -**

Planning for the formal training of user personnel in the operation of the new system is important. A new method may drastically affect people's lives by changing their work methods, work style and relationship with other employees. One of the most effective ways of dealing with the potential impact of these changes is to provide a well-designed program of training. The training program should:

a) Inform the about the system in general
b) Inform the user about specific operation of the system
c) Give the user some practice in operating the system
d) Provide opportunity for user feed back.
e) Provide ample opportunity to adjust to the new system.
f) Provide answers to the queries raised by the employees.
g) Generate a feeling among employees that the new system is "their" system.

Training

Even well designed and technically elegant systems can succeed or fail because of the way are operated and used. Therefore, the quality of training received by the personal involved with the

system in various capacities helps or hinders, and may even prevent, the successful implementation of an information system. Those whose will be associated with or affected by the system must know in detail what their roles will be how they can use the system, and what the system will or will not do. Both systems operators and users need training.

Training systems operators

Many systems depend on the computer-center personnel, who are responsible for keeping the equipment running as well as for providing the necessary support service. Their training must ensure that they are able to handle all possible operations, both routine and extraordinary. Operator training must also involve the data entry personnel.

If the system calls for the installation of new equipment, such as a new computer system, special terminals, or different data entry equipment, the operators training should include such fundamentals as how to turn the equipment on and use it, how to power it down, and a knowledge of what constitutes normal operation and use. The operators should also be instructed in what common malfunctions may occur, how to recognize them, and what steps to take when they arise. As part of their training, operators should be given both a troubleshooting lists that identifies possible problems and remedies for them, as well as the names and telephone numbers of individuals to contact when unexpected or unusual problems arise.

Training also involves familiarization with run procedures, which involves working through the sequence of activities needed to use a new system on an ongoing basis. These procedures allow the computer operators to become familiar with the actions they need to take (such as mount in magnetic disks or tapes, copying files, changing printer forms, or turning on communication systems), and when these actions must occur. In addition, they find out how long applications will run under normal conditions. This information is

important both to enable users to plan work activities and to identify systems that run longer or shorter than expected a sign that typically indicates problem with the run.

User Training

User training may involve equipment use, particularly in the case where, say, a microcomputer is in use and the individual involved is both operator and user. In these cases, user must be instructed first in how to operate the equipment. Questions that seem trivial to the analyst, such as how to turn on a terminal, how to insert a diskette into a microcomputer, or when it is safe to turn off equipment without danger of data loss, are significant problems to new users who are not familiar with computers.

User training must also instruct individuals in troubleshooting the system, determining whether a problem that arise is caused by the equipment or software or by something they have done in using the system. Including a troubleshooting guide in systems documentation will provide a useful reference long after the training period is over. There is noting more frustrating than working with a system, encountering a problem, and not being able to determine whether it is the user's fault or a problem with the system itself. The place to prevent this frustration is during training.

Training methods

The training of operators and users can be achieved in several different ways. Training activities may take place at vendor locations; at rented facilities, for example, in hotels or on university campuses; or in house at the employee's organizations. The methods and content of the training often vary, depending on the source and location of the training.

Vendor and In-Service Training

Often the best source of training on equipment is the vendor supplying the equipment. Most vendors offer extensive educational

program as part of their services, in some cases, there is a charge, but in many instances training is free. For example, IBM offers complimentary two and three-day courses to purchasers of many of their minicomputers and mainframe computers. The courses, offsite by experienced trainers and sales personnel, over all aspects of using the equipment, from how to turn it on and off, to the storage and removal of data, to handling malfunctions. This training is hands-on, so the participants actually use the system in the prescient of the trainers. if questions arise, they can quickly be answered. Since the system is intended for training, there is generally no rush to get training out of the way so that the productive use of the system can start. Training conducted at the organization's location might be rushed, a danger that installation personnel must guard against.

It special software such as a teleprocessing package or database management system is being installed, sending personnel to off-site short courses providing in-depth training is preferable to in-service training. These courses, which are generally provided for a fee, are presented to personnel from many organizations that are acquiring or using the same system. The benefit of sharing questions, problems, and experiences with persons from other companies is substantial. The personal contacts made during the sessions frequently last for years, with the continual sharing of information benefiting both parties. Short courses often involve additional time and costs for travel to other cities.

In-house Training

The advantage of offering training for the system on site is that the instruction can be tailored to her organization where it is being offered and focused on special procedures used in that setting, the organization's plans for growth, and any problems that have arisen. Often, the vendors or training companies negotiate fees and charges that are more economical and that enable the organization to

involve more personnel in the twining program than is possible travel is required.

There are also disadvantages. The mere fact that employees are in their own surroundings is distraction. Since telephone calls and emergencies can disrupt training sessions. Moreover, outside firms' come on-site, they many present courses that emphasize general concepts but that lack sufficient hands-on training. The training coordinator must recognize this possibility and deal with it an advance to ensure that the course content will meet operation needs.

In-house training can also be offered through special purchased instructional materials. A variety of professional training progarams on special topics can be rented or purchased from computer training firms such as Edutronics (McGraw-Hill, Inc.); Deltak, Inc; Professional Development, Inc; and Learning Corporation of America. Other vendors offer printed and audiovisual programmed instruction materials that are either self-instructional or that supplement other training activites

However, there is no substitute for hands on experience. Training manual are acceptable for familiarization, but the experiences of actually using the equipment, making and correcting mistakes, and encountering unexpected situations are the best and most lasting way of learning.

Conversion

Conversion is the process of changing form the old system to the new one.

Conversion Methods

There are four methods of handling a systems conversion. Each method should be considered in light of the opportunities that it offers and problems that it may cause. However, some situations dictate the use of one method over others, even though other

methods may be more beneficial. In general, system conversion should be accomplished as quickly as possible. Long conversion periods increase the possible frustration and users.

Parallel Systems

The moss secure method of converting from an old to new system is to run both systems in parallel. Under this approach, uses confiner to operate the old system in the accustomed manner but they also begin using the new system. This method is the safest conversion approach, since it guarantees that, should problems such as errors in processing or inability to handle certain types of transactions arise in sunning the new system, the organization can still fall back to the old system without loss of time, revenue, or service.

The disadvantages pf the parallel systems approach are significant. First of all, system costs double, since there are two sets of systems costs. In some instances it is necessary to hire temporary personnel to assist in operating both systems in parallel. Second, the fact that users know they can fail back to the old ways may be a disadvantage if there is potential resistance to the change of if uses prefer the old system. In other words, the new system may not get a fair trail.

All in all , the parallel method of systems conversion offers the mosst secure implementation plan if ting go wrong, but the costs and risks to a fair trail cannot be overlooked.

Methods of System Conversion

Method	Description	Advantage	Disadvantages
Parallel system	The old system is operated along with the new system	Offers greatest security. The old system can take over if errors are fond in the new system or if usage problems occur.	Doubles operating costs. The new system may not get fair trail.
Direct conversation	The old system replaced by the new one. The organization relies fully on the new system	Forces users to make the new system work. There are immediate benefits from new methods and controls.	There is no other system to fall back on if difficulties arise with new system. Requires the most careful planning
Pilot system	Working version of system implemented in one par of he organization. Based on feedback, changes are made and the system is installed in rest of the organization by one of the other methods.	Provides experience and live test before implementation.	May give the impression that the old system is unreliable and not error-free.
Phase- in	Gradually implement system across all users.	Allows some users to take advantages of the system early. Allows training and installation without unnecessary use of resources.	A long phase-in causes user problems whether the project gores well (over enthusiasm) or not (resistance and lack of fair trial).

Direct Cutover

The direct method converts form the old to the new system a abruptly, sometimes over a weekend or even overnight. The old system is used until a planned conversion day, when it is replaced by the new system. There are no parallel activities. It the analyst must make the change and wants to ensue that the new system fully replaces the old one so that users do not rely on the previous methods, direct cutover will accomplish this goal. Psychologically, it forces all users to make the new system work; they do not have any other method to fall back on.

The advantage of not having a fallback system can turn into a disadvantage if serious problems arise with the new system. In some instances, organizations even stop operations when problems arise so that difficulties can be corrected.

One organization allocated its entire accounting staff to entering data to start a new automated system. The task took approximately three weeks,, during which time none of the regular accounting operations that were to be converted to the new system were performed. Consequently, a three-week backlog of work developed. However, such backlog was expected and management had planned to authorize overtime work and the hiring of temporary assistance to catch up after conversion. Approximately two days before the direct cutover was not planning to preserve the data for accounts receivable aging. The manager stopped the conversion. As a result, the accounting staff had to catch up on three weeks work and reschedule the conversion to a date one-month later, when many of the previous steps had to be restarted. The system was finally implemented three months late, after much extra work, overtime, and staff frustration because of the way the cutover was handled.

Stopping conversion was a particularly drastic measurer. It would have been doubly bad had the steps been taken because of technical problems needing correction. If users know that a system

was once halted because of difficulties, they may not be fully confident that the system will be relaible, even if analysts tell them that the problems have been corrected. The time it takes to redo work that was stopped because of the conversion can be both lengthy and costly, and time lost can never be recaptured.

Direct cutover require cartful planning training cessions must be scheduled and maintained. The installation of all equipment must be on time, with ample days allowed in the schedule to correct any difficulties that occur. Any site preparation must be complete before the conversion can be done.

Direct conversions are quite common, particularly with purchased or turnkey system. For example, a hotel operation decided to install an automated reservation system. The entire system was implemented during a one-week period, when the computer system set up, the software loaded, and the system tested. During that week, a separate training crew worked with all the accounting and front desk personnel to familiarize them with the operation and use of the system. Theses activities occurred Monday through Saturdays. On Sunday, all personnel were brought in to enter reservations , guest charges, and accounting information into the new system so that it coincided with the day, the current system. On Sunday, evening, after the close of business for the day, the new system was started and used permanently. The old paper reservation file was removed, and the cash registers and bookkeeping machines were replaced with the terminals. The new system became live at midnight on Sunday. There was no old system to fall back on.

Pilot Approach

When new systems also involve new techniques or drastic changes in organization performance, the pilot approach is often preferred. In this method, a working version of the system is implemented in one part of the organization, such as a single work area or department. The users in this area typically know that they

are piloting a new system and that changed can be made to improve the system.

When the system is deemed completes, it is installed throughout the organization, either all at once (direct cutover method) or gradually (phase-in method.)

This approach had the advantage of providing a sound proving ground before full implementation. However, if the implementation is not properly handled, users may develop the impression that the system continues to have problems and that it cannot be relied on. For example, they may feel that the difficulties they experienced for two or three weeks may in fact not be gone just because the analysts claim they are.

Phase –In Method

The phase-in method is used when it is not possible to install a new system throughout an organization all at once. The conversion of files, training of personnel, or arrival or equipment may force the staging of the implementation over a period of time. Ranging form weeks to months. Some users will begin to take advantage of the new system before others.

For example, a medical system aimed at linking10 or 15 different clinics to hospital may phase in over a year. The work required to convert patient and insurance records on paper to files stored on magnetic disks requires 2 to 3 weeks for each clinic. A week of user training is also required for each clinic. Therefore, the analysts may phase this system in one clinic at a time, allowing 3 to 4 weeks each conversion. It is conceivable in this system that the full conversion will be phased over one year.

Long phase – in periods create difficulties for analysts, whether the conversions go well or not. If the system is working well, early users will communicate their enthusiasm to other personnel who are waiting for implementation. In fact, enthusiasm may reach such a

high level that when a group of users foes finally receive the system, there is a letdown. In the clinic example, for instance, the medical staff may exaggerate the time savings that accrue from not having to search for medical records or manually prepare insurance claims, activities that will be handled by the new system. Latter, when conversion occurs, the staff finds out that the system does not do the processing instantly. The disappointment is understandable.

On the other hand, if there are problems in the early phases of implementation, word of difficulties will spread also. Then the users may expect difficulties at the time of conversion and react negatively to the smallest mistakes. When systems are phased in, they must work well on the first conversion and all that follow.

Conversion Plan

The conversion plan includes a description of all the activities that must occur to implement the new system and put it into operation. It identifies the persons responsible for each activity and includes a timetable indicating when each activity will occur.

During the pre-implementation stages, when the conversion is being planed, analysts should assemble a lit of all tasks, including the following

1. List all files for conversion.
2. Identify all data required to build new filed during conversion.
3. List all new documents and procedures that go into use during conversion.
4. Identify all controls to be used during conversion. Establish proccefures for cross-checking old and new systems. Determine how team members will know if something has not been completed properly.
5. Assign responsibility for each activity.
6. Verify conversion schedules.

The conversion plan should anticipate possible problems and ways to deal with them. Among the most frequently occurring problem are missing documents, mixed data formats between current and new files, errors in data translation, missing data or lost files, and situations that were overlooked during systems development. The conversion manager must guar against the omission of steps in the conversion. A checklist will prevent missed steps. Personnel absences must also be expected and adequate fallback plans specified.

Conversion timing is challenging, since there are so many aspects of the conversion, ranging from the installation of equipment to the ordering forms and supplies.

Operating Plan:

The operating plan is checking of all arrangements. It includes reviewing conversion plans, verifying the delivery of equipment, software forma, preparing the site and preparing the data and files.

1. **Site Preparation:** Analysts often work with vendor personnel to outline site-preparation guidelines. Due importance should be paid to electrical using air conditioning needs, humidity controls, space requirements, etc.
2. **Data and File Preparation:** For a new system to begin master files and system files need to be entered into the system before the normal functioning of the system. Master files are generally created manually. The number of records in older system master file should tally with the number of records in new master file.

In case of financial software the balance brought forward should be checked for validation before implementation of the new system.

UNIT III
LESSON NO. 11
IMPLEMENTATION AND CONTROL OF PROJECT

A major element in building system is selecting compatible Hardware & software. The kind of hardware & peripherals required is to be determined. The suitable has to be selected. The experienced analysts will explore various options regarding it. Hardware/software selection begins with requirements analysis, followed by a request for proposal and vendor evaluation. The final system selection initiates contract negotiations, price, maintenance agreements, vendor selection, acceptance criteria and similar issues.

Hardware Selection

Gone are the days when a user calls IBM to order a 360 system, which in itself included hardware, software & support. Today, selecting a system is a serious and time concurring activity. Unfortunately, many systems are still selected based on vendor reputation only or other subjective factors. Instead the factors, which are to be considered, should be determining equipment size, capacity needs, financial considerations and acquisition method.

Determining size and capacity requirements

With computers ranging in size from small microcomputers to large mainframe systems, the number of options to choose from when selecting a system is obviously very large. Even within the lines of a single manufacturer, there are many different models and configurations from which to select. How then does the analyst determine which system to use when a new computer is to be acquired?

The starting point in an equipment decision process is the size and capacity requirements. One particular computer system may be appropriate for one workload and inappropriate for another. Systems

capacity is frequently the determining factor. Relevant features to consider include the following:

1. Internal memory size

2. Cycle speed of system for processing

3.Characteristics of display and communication components

4. Types and numbers of auxiliary storage units that can be attached

5. Systems support and utility Software provided or available

Frequently, software needs dictate the minimum configuration required. For instance, if a particular program to be run on a microcomputer requires, say, 4 megabytes of storage, the list of feasible candidates will exclude all systems, regardless of their attractiveness, that do not have or that cannot be easily configured to have or that cannot be easily configured to have a memory of at least 4 megabytes.

All systems have limits, depending on what they are designed for. The limits may or may not be a factor, in a particular selection decision. For example, some systems communicate data only in a synchronous fashion. If the system has other attractive features and will not be used for data communications or teleprocessing, the synchronous feature may be of little concern. However, if the primary application for the computer requires synchronous transmission of ASCII data, the bisynchronous limitation is important. Likewise, the fact that a particular minicomputer is limited to five ports for connecting terminals and printers may be too restrictive in a teleprocessing system designed to link 23 sites together through terminals and communications lines.

Software needs often dictate hardware requirements such as internal memory sizes, communication ports, disk-capacity, and the ability to use magnetic tape. Vendors are reliable sources of configuration requirements. They can provide information on the minimum configuration requirements needed to use their software

properly. Trade newspapers and magazines provide regular distribution of information about hardware and software requirements. In addition, subscription services offer information on operating, specifications. These services, which cost several hundred dollars yearly, provide monthly updates (generally using a loose-leaf binder format) and telephone assistance for computer operation, as well as user comments.

Auxiliary storage capacity is generally determined by file storage and processing needs. To estimate the disk storage, needed for a system, the analyst must consider the space needed for each master file.

Design of Synthetic Programs

A synthetic job is a program written to exercise a computer's resources in a way that allows the analyst to imitate the expected job steam and determine the results. Then the artificial job stream can be adjusted and rerun to determine the impact. The process can be repeated, as many times as necessary to see which takes a comparison set of computer handles well and which they do not handle as well.

The synthetic job can be adjusted to produce the same type of activity as actual programs, including perhaps random access of files, sequential searching of files with varying size records, input and output activities and file accessing in varying random patterns. The type of hardware and software features that are often simulated are as under:

HARDWARE	SOFTWARE
CPU Processing speed Memory access speed Interrupt handling abilities Peripheral channel speed. Printer speeds Seek time for magnetic disk Rotational delay for magnetic disk. Communication speeds.	Scheduling algorithm. Compilation algorithm. Code efficiency. Virtual storage management algorithm File handling efficiency. Interrupt handling. Indexing methods. Multiple buffer handling. Communication processing procedure.

Comparison of Benchmarks

Although some comparison on the basis of equipment performance is better than no comparison at all, there are drawbacks to the use of benchmarks, first of all, the comparisons are made on purely quantitative grounds. They do not relate the learning time needs to become accustomed to the system or the quality or the systems software (such as the quality of the diagnostics produced during compilation or the efficiency of the object code produced).

In addition, benchmarks do not provide reasonable assurances that programs currently being used on an existing system can be converted to the new system or that the new machine will run them efficiently even if they are converted. Vendors may also make sales claims that a specific system can handle additional tasks that another system cannot. Since benchmarks cannot directly verify these claims, the purchaser may insist that statements of certain sales claims be attached in writing to the sale contract.

Plug – Compatible Equipment

For reasons of cost, analysts frequently consider using equipment for a particular make of computer that is not manufactured by the computer vendor. Such components are called plug compatible equipment. Some companies specialize in manufacturing systems components, such as printers, disk drives, or memory units that can be connected to a vendor's system in place of the same equipment manufactured by the vendor. The central processing unit does not care or know that the equipment is not the same make.

The benefit of plug – compatible equipment is the lower cost of an item compared with one produced by a major computer vendor. Because firms specializing in specific components can develop manufacturing expertise or are likely to have a smaller investment in research and development - they are duplicating components developed by another firm - they are able to offer the same product at a lower cost.

Although there is a large market for plug-compatible equipment because of price differences, the analyst must ensure that the equipment will meet necessary quality levels, that it will perform as well as (or possibly better than) the original equipment, and the computer vendor will not allow warranties and service agreements of the system. There is a danger that some service people employed by the vendor will have malfunctions on the “foreign” agreements on maintenance and methods for resolving possible disputes about malfunction.

Financial Factors

The acquisition of and payment for a computer are usually handled through one of three common methods: rental, lease, or purchase. Determining which option is appropriate depends on the

characteristics and plans of the organization at the time of the acquisition is made. No one option is always better than the other.

Rental

Computer rental is for the short- term use of a system, generally form 1 to 12 months. Each month a payment is made for the use of the equipment. Both the user and supplier have the option of canceling the rental with advance, usually 30 or 60 days ahead of the termination date.

Because the commitment is short-term, the renter has a great deal of flexibility. The decision to purchase a system can be delayed until financing is adequate, until a new generation of equipment is available, or until such time as the organization wishes, for whatever reason. Flexibility can be particularly important when an organization is experiencing planned rapid growth and will outgrow a specific system in a brief period, when important reorganization of divisions and departments that will affect compuring resources are in progress, or when the enterprise is in a period of dynamic change.

Compared with other acquisition methods rental is the most expensive. Monthly payments are higher, and the organization does not receive any tax or ownership benefits, other than deduction of the monthly rental as a business expense. The equipment received is often used, although the rental agreement should the written in such a way that the renter is assumed of having a agreement that runs properly and the will be maintained adequately. The short-notice cancellation provision may not provide enough security for the renter to plan on the continued availability of the system. For this reasons, rental is typically a short-term solution that is appropriate perhaps while awaiting the official announcement and delivery of new system. Many firms refuse to tie up capital or equipment for short term rentals. The analyst must ensure that rental systems are even available before making such a decision, since not all suppliers offer short-term rental.

Lease

As lease a commitment to use a system for a specific time, generally from three to seven years. Payments are predetermined and do not change throughout the course of the lease. Depending on the terms of the lease, payments are monthly, semi-annual, or annual and include the cost of equipment service and maintenance. At the end of the lease period the lesser generally does not own the equipment. (if that is not the case, and the equipment becomes the property of the lesser, the Internal Revenue Service considers the agreement a conditional sale and the entire transaction must then be created as a purchase.)

Compared with rental, leasing is less expensive. Because there is a longer commitment the supplier will generally provide better service and the user can count of having the system available for use. Leasing protects against technical obsolescence always a concern when purchasing computer equipment. If the lease term is short, the lessor can upgrade to a more powerful system even though the lease has not expired, providing the system is acquired from the same manufacturer.

No capital investment is required to lease a computer system. Leasing offers specific tax advantages. In addition to deducting the cost of the lease as a business expense, tax credits are sometimes business pays. In some case, the title for the equipment can be passed to the lessor. Legal assistance is needed to investigate the current terms and conditions allowed by the Internal Revenue Service at the time such a transaction is considered.

Purchase

The ownership of computers through outright purchase is the most common method of computer acquisition and is increasing in popularity as lease costs rise. Over time, the purchase option

frequently costs the least, especially in light of the tax advantages that can some - times be gained.

Under purchase, the organizations take title to the equipment. Of course, the money for the purchase must be taken from operating funds or borrowed. And, in a sense the organization is locked in to the system it purchases, since changing to a different computer system is more difficult either the system must be sold or arrangements must be negotiated to trade it in on a different computer.

The organization must acquire its own maintenance services (for parts and labour), usually from the manufactures, and pay the monthly charges, which fluctuate from year to year. In addition, if the equipment was financed, payment on the loan must be made periodically. The cash outflow still may be lower than with renting or leasing, depending on the terms arranged by the purchase. In return for the outgoing cash, purchase offers specific tax advantages:

1. The monthly maintenance charges are deductible as a business expense.

2. Interest on any loan to finance the purchase is deductible as a business expense.

3. The cost of the equipment can be depreciated over time; this also lowers the taxable income and therefore the income taxes paid.

4. Local, state, and federal taxes paid on the purchase may be deductible from income taxes.

The purchase option indicates the use of depreciation to reduce taxes. In a sense then, depreciation deductions on income tax reduce the cost of the computer to the organization. Normally, this benefit is not possible under lease agreements and it is never feasible for short-term rentals. Of course, the tax benefits described apply only to firms that operate for profit. Non profit firms that do not pay

income taxes thus do not receive tax benefits from computer purchase.

Method of acquisition	Advantages	Disadvantages
Rental	Short-term commitment. High level of flexibility. Does not require cash up front.	Most expensive option. Little control of equipment change. Not all vendors will rent.
Lease	Predetermined payments for fixed period. Does not require cash up front. Usually better service from vendor than under rental. Little risk of obsolescence. Less expensive than rental	More expensive than purchase. May have limitations on hours of equipment use.
Purchase	Least cost in long run. Distinct tax advantages if a profit-making firm. A business investment. Full control over equipment use.	Risk of obsolescence. Permanent commitment. Full responsibility for all problems. Greater early cash requirements than other options.

Maintenance and Support

An additional factor in hardware decision concern the maintenance and support of the system after it is installed. Primary concerns are five source of maintenance, terms and response times.

Maintenance Source

Once the system is delivered and installed, there is a brief warranty period during which time the sales unit is responsible for maintenance. This is typically a 90 day period, although the specific terms fare subject to contract negotiation. After that time, the

purchaser has the option acquiring maintenance from various sources.

The most common source of maintenance for new equipments is the firm which it was purchased through the manufacture's sales force, there is also generally a maintenance support group that provides service for a standard price. Large compaines set national maintenance costs that are adjusted on an annual or semi-annual basis. If the system is a microcomputer or personal computer, the dealer generally provides maintenance as a chargeable service. The buyer may pay a lower purchase price for mail-order houses, but may lose the convenience of local service. Lower service costs are one reason some mail-order firms are able to offer lower purchase prices.

Service is also available from companies specializing in providing maintenance service. Third party maintenance companies as these firms are called, frequently provide service in smaller communities, where manufactures do not find it cost-effective to maintain offices. In addition, sellers of turnkey systems, who deliver and install working hardware and software combinations but do not manufacture the equipment themselves, suggest the use of specific third-party maintenance firms with whom they work directly and inform of changes in hardware, software, and suggested maintenance procedures. Sales organization, the purchaser may have no choice but to use a third party maintenance firm. Many manufacturers do not service equipment they did not sell.

Terms

On formulating a maintenance agreement, the terms of the agreement are as important as the cost. The contract may be written to cover both labor and parts (all parts regardless of the number needed or their cost), labor and an allowance for parts, or labor only, with parts charges added on as needed. The type of contract desired depends on the expenditures the organization is willing to make in comparison with how frequently it estimates service will be

required. The labor and parts form is the most common type of contract of large systems.

The analyst should also consider how maintenance costs would change. Large manufactures have established policies of adjusting their maintenance charges on an annual or semiannual basis and frequently will not change these policies for any customer. Other suppliers and service companies offer open-ended contracts that allow the adjustment of charges at any time with 90 day notice. Frequently, analysts negotiating service with these companies will seek a cap on maintenance; that is, they will seek agreement, in writing, that the maintenance costs will not increase by any more than a stated maximum amount during a specific period, such as a calendar year. This type of protection ensures that the supplier cannot take advantage on the user is totally dependent on the service agency. Most service companies are very reputable, but good business practice dictates that adequate protection always is sought in contracting for services.

Service and Response

Maintenance support is useful only if it is available when needed. Two concerns in maintenance are the response time when service is requested and the hours of support.

When a telephone call is placed for emergency maintenance, will a technician or engineer be dispatched immediately? That may be unlikely. However, the user has right to expect a reasonable response time after making an emergency call. Organizations often specify in the contract that the response to a telephone call must be made within 2 hours. Others specify same-day response, and still others accept response not later than the next morning. The degree of dependency the user organization has on the computer system will dictate how these terms are negotiated. An online system that is in use for 24 hours a day will need a much quicker response that one that is used intermittently for batch processing.

Repair service is often provided only during normal working hours. If an organization wishes evening service or around-the-clock coverage, it is usually available for an extra charge, say, from 10 percent to 50 percent additional cost.

However, equally important is the need for performing preventive maintenance, the routine service or cleaning and adjusting the equipment to prevent breakdowns. Whenever contracting for maintenance, a schedule of preventive maintenance must be agreed on in advance. Information about manufacturers suggested preventive maintenance cycles and procedures should be field in the systems department and included in service agreements.

In all instances, the stocking of sufficient spare parts is important since good service is impossible if spare parts are not available. User organizations should obtain sufficient assurances about adequate parts inventories in advance of need.

Options to In-House Systems

Less common options for computer support include the use of service bureaus of facilities management companies. A service bureau is a company that owns computer facilities and makes them available to users for a charge. The user submits data for processing, which is performed at the service bureau on the bureau's computer systems. In some cases, organizations interact directly with the computer though terminals located in users offices. There is usually a monthly cost plus a charge that varies according to the amount of time the user is in communication with the system. Additional fees may be charged for storing data, mounting magnetic disks and tapes, or printing pages.

Some service bureaus provide data processing service. The bureau prepares the data for input, handles all processing, and may even provide pickup and delivery service. Custom programming is available for charge.

The use of service bureaus is very common in accounting and payroll applications. Of the firms that want automatic data processing services in these areas but that do not want to purchase equipment or hire systems personnel will contract with a service bureau. However, as computer costs continue to drop and high-quality commercial software is available the reliance of some firms on service bureaus may change.

Facilities management companies provide a service to companies that wish to develop information systems capabilities but that prefer not to maintain a staff of operators, analysts, and programmers. Under this option, the user organization may purchase a computer system and then contract with a facilities management firm to operate the computer and premises service on the organization's premises. The facilities management company provides the information system expertise and personal for a free. It also develops software or acquires commercial software to meet the organization needs.

Through facilities management as organisations can obtain professional information processing and service without investing time and resources in managing a systems staff while still receiving the benefits of owning a computer system.

Vendor Selection

This step determines the "winner" among the list of vendors available. The vendor with the best combination of reputation, reliability, service record, training delivery time, lease/finance terms & conversion schedule is selected. Initially a decision is made as to which vendor to contact. The sources available to check on vendors include:

1. Users
2. Software houses
3. Trade Associations
6. Vendor software list
7. Vendor referral directories
8. Published Directions

4. Universities 9. Consultants

5. Publications 10 Industry Contacts

11 Vendor's annual financial statements.

After this data is gathered about a vendor, it is matched with the selection criteria. Few of the selected vendors are invited to give presentation of their system. The system chosen goes through contract negotiations before implementation.

Software Selection

Software Selection is a critical aspect of system development. The search starts with the software, followed by the hardware. There are two ways of acquiring software: custom:- made or "off-the shelf" packages. Today's trend is toward purchasing packages, which represent roughly 10 percent of what it costs to develop the same in house. In addition to reduced cost, there are other advantages:

1. A good purchase can get the system running in a matter of days rather than the weeks or months required for "home-grown" packages.
2. MIS personnel are released for other projects.
3. Packages are generally reliable and perform according to stated documentation.
4. Miminum risks are usually associated with large-scale systems and programming efforts.
5. Delays in completing software projects in house often occur because programmers quit in midstream.
6. It is difficult to predict the cost of "home-grown" software.
7. The user has a change of seeing how well the package performs before purchasing.

There are drawbacks, however, to software package:

1. The package may not meet user requirements adequately.
2. Extensive modification of a package usually results in loss of the vendor's support.
3. The methodology for package evaluation and selection is often poorly defined. The result is a haphazard review based on a faulty process or questionable selection criteria.
4. For first time software package users, the overall expectation from a packages is often unclear and ill defined.

It can be seen, then, that the quality of a software package cannot be determined by price alone. A systematic review is crucial.

Criteria for Software Selection

Prior to selecting the software the project team must set up criteria for selection. Selection criteria fall into the categories described here.

Reliability

It is the probability that the software will execute for a specified time period without a failure weighted by the cost to the user of each failure encountered. It relates to the ease of recovery and ability to give consistent results. Reliability is particularly important to the professional user. For example, a pharmacist relies on past files on patients when filling presumptions. Information accuracy is crucial.

Hardware may become inoperative because of design errors, manufacturing errors, or deterioration caused by heat, humidity, friction, and the like. In contrast, software does not fail or wear out. Any reliability problems are attributable to errors introduced during the production process. Furthermore, whereas hardware

failure is based largely of random failures, software reliability is based on predestined errors.

Although reliable software brings up the concept of modularity, or the case with which a package can be modified. This depends on whether the package was originally designed as a package or was retrofitted after its original development for signal installation use. A package with a high degree of modularity has the capacity to operate in many machine configurations and perhaps across manufactures product lines.

With modularity come expandability, which emphasizes the sensitivity of a software package to handle an increased volume of transaction or to integrate with other programs. The following questions should be considered:

1. Is there room for expanding the master file?
2. How easily can additional fields and files be added/
3. Are there errors a user can make that will ring down the system?
4. How much of the system becomes unusable when a part of it fails?
5. What are the recovery capabilities?

Functionality

It is a definition of the facilities, performance, and other factors that the user requires in the finished project. All such information comes from the user. The following are key questions to consider.

1. Do the input transactions, files, and reports contain the necessary data elements?
2. Are all the necessary computations and processing performed according to specifications.

Capacity

Capacity refers to the capability of the software package to handle the user's requirements for size of files, number of data elements, volume of transactions and reports and number of occurrences of data elements. All limitations should be checked.

Flexibility

It is a measure of the effort required to modify an operational program. One feature of flexibility is adaptability, which is a measure of the ease of extending the product.

Usability

This criterion refers to the effort required to operate, prepare the input and interpret the output of a program. Additional part is to be considered are reliability and understandability. Relaibalilty refers to the ability of software to be used on different hardware and operating systems. Understandability means that the purpose of the product is clear to the evaluator and that the package is clearly and simply written, is free of jargon, and contains sufficient references to modify available documents so that the reader can comprehend advancements..

Security

It is a measure of the likelihood that the systems user can accidentally or internationally access or destroy unauthorized data. A key question s how well can one control access of software or data file? Control provides system integrity.

Performance

It is a measure of the capacity of the software package to do what it is expected to do. This criterion focuses on throughout, or how effectively a package performs under peak loads. Each package should be evaluated for acceptance on the user's system.

The language in which a package is written and the operating system are additional performance considerations. If we plan to modify or extend a package, it is easier if it is written in a language that is commonly known to programmers. Likewise, if the package run only under a disk operation system and the installation is under a full operation system, then either the package will have to be upgraded to the larger operating system or the system downgraded to handle the package as is. In either case, the change could be costly and counterproductive.

Minimal costs

Cost is a major consideration in deciding between in- house and vendor software. Cost- conscious have consider the following points.

1. Development and conversion costs.
2. Delivery schedule.
3. Cost and frequency of software modifications.
4. Usable life span of the package.

Performance Evaluation

Evaluating a system includes the hardware and software as a unit. Hardware selection requires an analysis of several performance categories.

1. System availability. When will the system be available?
2. Compatibility. How compatible is the system with existing programs?
3. Cost. What is the lease or purchase price of the system? What abut maintenance and operation costs?
4. Performance. What are the capacity and throughout of the system?

5. Uptime. What is the ‘uptime’ record of the system? What maintenance schedule is required?
6. Support. How competent and available is the vendor’s staff to support the system?
7. Usability. How easy is it to program, modify and operate the system?

For the software evaluation, the following factors are considered:

1. The programming language and its suitability to the application (s).
2. Ease of installation and training.
3. Extent of enhancements to be made prior to installation.

In addition to hardware/software evaluation, the quality of the vendor’s services should be examined. Vendor support service include the following:

1. Backup. Emergency computer backup available from vendor.
2. Conversion. Programming and installation service provided during conversion.
3. Maintenance. Adequacy and cost of hardware maintenance.
4. System development. Availability of competent analysis and programmers for system development.

UNIT IV

LESSON NO. 12

INTEGRATED COMPUTERS TO INFORMATION SYSTEM AND DBMS

The design translates the system requirements into ways of operationalizing them. The design is a solution, a "how to "approach, compared to analysis, a "what is" orientation. The design phase focuses on the detailed implementation of the system recommendation in the feasibility study. Emphasis is on translating performance into design specifications. The design phase is a transition from a user oriented document to a programmer oriented document.

Modularization

One way to plan a new system is to focus on each functional subsystem as a separate entity or application area. Using such an approach, each application area is treated as if it were totally independent. There is minimal sharing of information and system processes between areas. For example, if two major systems efforts were being simultaneously undertaken. One in the order department & the other in the accounts section. The orders affects the amount of receivables, amount of receivables affect customer's credit, validate the order and much more. from an application point of view, the order processing subsystem should be deigned to meet accounts receivable functional requirements and vice versa. However, there would be no need to review each application area for common internal processes. Both the systems would be performing certain same steps in each of their systems individually.

The modular systems approach divides each application area into a number of smaller units called modules. These modules may apply to a particular application, or they may be common to

two or more application areas. Modules may be used only, once or they may be used several times during the processing of an application. Breaking up of a problem into smaller manageable parts is certainly beneficial.

The advantages of modularization are:-

1. It can speed up the systems process in general & the computer programming function in particular.
2. It eliminates unnecessary duplications.
3. It can in higher quality become of the concentrated efforts devoted to the development of common module.
4. It provides better control over the total system project, since work can be segmented and assigned in smaller, more controllable units.
5. It more efficiently maintains the system as a correction at one place rectifies the entire problem.
6. It allows flexibility as additional features may be additional futures may be added later.
7. Small parts of the system can be tested separately.

Certainly these factors present a strong argument in favour of the modularization. However there are certain limitations to it as follows:

1. Numerous unique application requirements which must be incorporated in common modules. If a single module is to accommodate all situations, it will become very large & complex.

2. Many systems, for particular application areas. Many times a high rate of change means a high rate of potential error. When these changes and errors affect common modules, the negative consequences can be widespread.

Modular systems design is best viewed as one aspect of a broader planning issue, but it is not a required step in the design process. The analyst, based upon the in-depth understanding of problem, specifies the level of modularization.

Files: The data is stored in files according to user requirements. Some records are processed daily whereas others are updated at random. Depending upon the way the data will be used, the file is organized.

Basic file Related Keywords:

Byte:-It is the smallest addressable unit in computer. A byte is a set of 8 bits and represents a character.

Element: It is a combination of one or more bytes. It is referred to as a field. A field is actually a physical space on tape or disk .A roll number, age, name of employee etc. are examples of it.

Record :- The elements related to are combined into a record. An employee has a record with his name, designation, basic pay, allowances, deductions etc. as its fields. A record may have a unique key to identify the record. Records are represented as logical & physical records. A logical record maintains a logical relationship among all the data items in the record. It is the way the program or user sees the data. In contrast a physical record is the way data are recorded on a storage medium.

File:- It is a collection of similar records. The records will have the same fields but different values in each record. The size of a file is limited by the size of memory available.

Database: It is a set of interrelated files. The files in combination tend to link to a common solution. For example, a student attendance file, a student result file, a student admission file, etc. are related to academic software pertaining to students.

File Design

A file is organized to ensure that recodes are available for processing. It should be designed in the line with the activity and volatility of the information and the nature of the storage media and devices. Other considerations are (1) cost of file media (highest for disk, lowest for tape) (2) inquiry requirements (real-time versus batch processing) and (3) file privacy, integrity, security, and confidentiality.

There are four methods of organizing files: sequential, indexed- sequential, inverted list and direct access. Each method is explained as under.

1. Sequential Organization

Sequential organization simply means storing and sorting in physical, contiguous blocks within files on tape or disk. Recorders are also in sequence within each block. To access a record, previous records within the block are scanned. Thus sequential record design is best suited for "get next" activities, reading one record after another without a search delay.

In a sequential organization, record can be added only at the end of the file. It is not possible to insert a record in the middle of the file, without rewriting the file. In a data base system, however, a record may be inserted anywhere in the file, which would automatically resequence the records following the inserted record. Another approach is to add all new records at the end of the file and later sort the file on a key (name, number, etc.). Obviously, in a 60,000- record file it is less time-consuming to insert the few records directly than to sort the entire file.

In a sequential file update, transaction records are in the same sequence as in the master file. Records from both files are matched, one record at a time, resulting in an update master file. For example,

the system changes the customer's city of residence as specified in the transaction file (on floppy disk) and corrects it in the master file. A "C," in the record number specifies "replace"; and "A" "add"; and a "D" "delete."

In a personal computer with two disk drives, the master file is loaded on a diskette into drive A, while the transaction file is loaded on another diskette into drive B. Updating the master file transfers data from drive B to A, controlled by the software in memory.

2. Indexed-Sequential Organization

Like sequential organization, keyed sequential organization store data physically contiguous blocks. The difference is in the use of index to locate records. To understand this method, we need to distinguish among three areas in disk storage: Prime area, overflow area and index area. The prime area contains file records stored by key or ID numbers. All records are initially stored in the prime area. The overflow area contains records added to the file that cannot be placed in logical sequence in the prime area. The index area is more like a data dictionary. It contains keys of records and their locations on the disk. A pointer associated with each key is an address that tells the system where to find a record.

In an airline reservation file, the index area might contain pointers to the Chicago and Delhi flights. The Chicago flight points to the Chicago flight information stored in the prime area. The Delhi flight points to the Delhi flight information in the prime area. Lack of space to store the Brisbane flight in sequential order make it necessary to load it in the overflow area. The overflow pointer places it logically in sequential order in the prime area. The same arrangement applies to the other flights.

Indexed- sequential organization reduces the magnitude of the sequential search and provides quick access for sequential and direct processing. The primary drawback is the extra storage space required

for the index. It also takes longer to search the index for data access or retrieval.

Chaining

File organization requires that relationship be established among data items. It must show how characters form fields, fields form files, and files relate to one another. Establishing relationship is done through chaining or the use of pointers. The example on airline reservation file showed how pointers link one record to another. Part number retrieves a record. A better way is to chain the records by linking a pointer to each. The pointer gives the address of the next type of the same class. The search method applies similarly to other parts in the file.

3. Inverted list Organization

Like the indexed-sequential storage method, the inverted list organization maintains an index. The two methods differ, however, in the index level and record storage. The indexed-sequential method has a multiple index for a given key, whereas the inverted list method has a single index for each key type. In an inverted list, records are not necessarily stored in particular sequence. They are placed in the data storage area, but indexes are updated for the record keys and location.

Data for our flight reservation system has a separate index area and a data location area. The index area any contain flight number and a pointer to the record present in the data location area. The data location area may have record numbers along with all the details of the flight such as the flight number, flight description, and flight departure time. These are all defined as keys, and a separate index is maintained for each. In the data location area, flight information is in no particular sequence. Assume that a passenger needs information about the “Delhi flight”. The Data Base Management System (DBMS) then reads the single-level index sequentially until

to finds the key value for the Delhi flight. This value may have two records associated with it. The DBMS essentially tells the agent the departing time of the flight. Looking at inverted-list organization differently, suppose the passenger requests information's on a Delhi flight that departs at 8:15. The DBMS first searches the flight description index for the value of the "Delhi flight". It finds both the records. Next it searches the flight departure index for these values. It finds that one of them departs at 10:10, but the other departs at 8:15. The later record in the data location area is displayed for follow-up.

It can be seen that inverted lists are best for application that request specific data on multiple keys. They are ideal for static files because additions and deletions cause expensive pointer updating.

4. Direct-Access organization

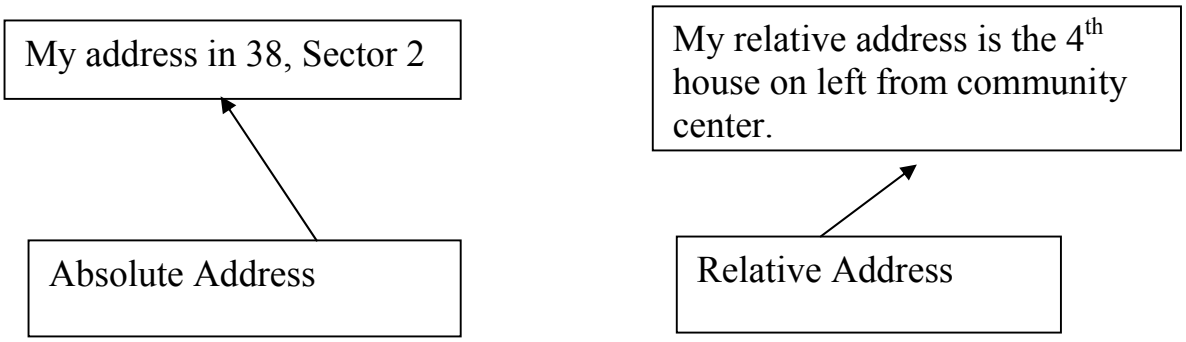
In direct- access file organization, records are placed randomly throughout the file. Records need not be in sequence because they are updated directly and rewritten back in the same location. New records are added at the end of the file or inserted in specific locations based on software commands.

Records are accessed by addresses that specify their disk locations. An address is required for location a record, for linking records, or for establishing relationship. Addresses are of two types; absolute and relative. An absolute address represents the physical location of the record. It is usually stated in format of sector/track/record number. For example, 3/14/6 means go to sector 3, track 14 of that sector, and the sixth record of the track. One problem with absolute addresses is that they become invalid when the file that contains the records is relocated on the disk. One way around this is to use pointers for the updated records.

A relative address gives a record location relative to the beginning of the file. There must be fixed-length records for

reference. Another way of locating a record is by the number of bytes it is from the beginning of the file (see Figure 1). Unlike relative addressing, if the file is move, pointers need not be update, because the relative location of the record remains the same regardless of the file location.

FIGURE 1 Absolute and Relative Addressing-An Example



Thus each file organization method has advantages and limitations. Many applications by their nature are best done sequentially. Payroll is a good example. The system goes through the employee list, extracts the information and prepares pay slips. There are no lengthy random-access seeks. In contrast, real-time applications where response requirements are measured in seconds are candidates for random-access design. Systems for answering inquires, booking airlines or stadium seats, updating checking or savings accounts in a bank, or interacting with a terminal are example for fandom-access design.

FIGURE 2
FILE ORGANIZATION METHODS- A SUMMARY

Method	Advantages	Disadvantages
Sequential	Simple to design. Easy to program. Variable length & Blocked records available Best use of software space	Records cannot be added to middle of file
Indexed sequential	Records can be inserted or Updated in middle of life. Processing may be carried out Sequentially or randomly	Unique keys required Processing occasionally slow reorganization of file required.
Inverted list	Used in application requesting specific data on multiples keys.	
Random	Records can be inserted or updated in middle of file. Better control over record allocation.	Calculating address required for processing. Variable-length records nearly impossible to process.

Data Base Design

A decade ago, database was unique to large corporations with mainframes. Today it is recognized as standard of MIS and is available for virtually every size of computer. Before the data base concept became operational, users had programs the handled their own data independent of other users. It was a conventional the environmental with no data integration or sharing of common data across applications. In a database environment, common data are available and used by several users. Instead of each program (or user) managing its own data, data accrues applications are shared by authorized users with the data base software managing the data as an entity. A program now requests data through the data base management system (DBMS), which determines data sharing.

Objectives of Data Base

The general theme behind a database is to handle information as an integrated whole. There is none of the artificiality that is normally embedded in separate file or applications. A database is a collection of interrelated data stored with minimum redundancy to serve many users quickly and efficiently. The general objective is to make information access easy, quick, inexpensive and flexible for the user. In database design, several specific objectives are considered:

1. **Controlled redundancy:** Redundant data occupies space and, therefore, is wasteful. If versions of the same data are in different phases of updating, the system often gives conducting information. Unique aspects of data base design in storing data only once, which controls redundancy and improves system performance.
2. **Ease of learning and use :** A major feature of a user- friendly database package is how easy it is to learn and use. Related to this point is that a database can be modified without interfering with established ways of using the data.
3. **Data Independence:** An important database objective is changing hardware and storage procedures or adding new data without having to rewrite application programs. The database should be “tunable” to improve performance without rewriting programs.
4. **More information at low cost:** Using, storing and modifying data at low cost are important. Although hardware prices are falling, software and programming costs are on the rise. This means that programming and software enhancements should be kept simple and easy to update.

5. **Accuracy and integrity:** The accuracy of a database ensures that data quality and content remain constant. Integrity controls detect data inaccuracies where they occur.
6. **Recovery from failure:** With multi-user access to a database, the system must recover quickly after it is down with no loss of transactions. This objective also helps to maintain data accuracy and integrity.
7. **Privacy and security:** For data to remain private, security measures must be taken to prevent unauthorized access. Database security means that data are protected from various forms of destruction; users must be positively identified and their actions monitored.
8. **Performance:** This objective emphasizes response time to inquiries suitable to the use of the data. How satisfactory the response time is depends on the nature of the user-data dialogue. For example, inquires regarding airline seat availability should be handled in a few seconds. On the other extreme, inquiries regarding the total sale of a product over the past two weeks may be handled satisfactorily in 50 seconds.

In a data environment, the DBMS is the software that provides the interface between the data file on disk and the program that requests processing. The DBMS stores and manages data. The procedure is as follows:

1. The user requests a sales report through the application program. The application program uses a data manipulation language (DML) to tell the DBMS what is required.
2. The DBMS refers to the data model, which describes the view in a language called the data definition language (DDL). The DBMS uses DDL to determine how data must be structured to produce the user's view.

3. The DBMS requests the input/output control system (IOCS) to retrieve the information from physical storage as specified by the application program. The output is the sales report.

To summarize,

1. DML manipulates data; it specifies what is required.
2. DDL describes how data are structured.
3. DBMS manages data according to DML descriptions. DBMS performs several important functions:

1. Storing, retrieving, and updating data.
2. Creating program and data independence. Either one can be altered independently of the other.
3. Enforcing procedures for data integrity. Data are immune from deliberate alteration because the programmer has no direct method of altering physical databases.
4. Reducing data redundancy. Data are stored and maintained only once.
5. Providing security facilities for defining users and enforcing authorization. Access is limited to authorized users by passwords or similar schemes.
6. Reducing physical storage requirements by separating the logical and physical aspects of the database.

Logical and Physical Views of Data

In data base design, several views of data must be considered along with the persons who use them. In addition to data structuring, where relationship are reflected between and within entities, we need to identify the application program's logical views of data within an overall logical data structure. The logical view is what the data look like, regardless of how they are stored. The physical view is the way data exist in physical storage. It deals with how data are stored,

accessed, or related to other data in storage. Four views of data exist: three logical and one physical. The logical views are the user's view, the programmer's view and the overall logical view, called a schema.

Schemas and Subschemas

The schema is the view that helps the DBMS to decide what data in storage it should act upon as requested by the application program. An examle of a schema is the arrival and departure display at an airport. Scheduled flights and flight numbers (schema) remain the same, but the actual departure and arrival times may vary. The user's view might be a particular flight arriving or departing at a scheduled time. How the flight actually takes off or lands is of little concern to the user. The latter view is of subschema. It is a programmer's (pilot's) view. Many subschemas can be derived from one schema, just as different pilots visualize views of a landing approach, although (it is hoped) arrive at the scheduled time indicating on the CRT screen display (schema)

Different application programmers visualize different subschemas. The software provides the relationship among the schema, subschema and physical structure.

Data Structure

Data are structured according to the data model. In any sales example, sales items are linked to the salesperson that sold them. The salesperson is called an entity and the item sold is also an entity. An entity is a conceptual representation of an object. Relationships between entities make up a data structure: A data model represents a data structure that is described to the DBMS in DDL.

Types of Relationships

Three types of relationships exist among entities: one-to-one, one-to-many, and many-to-many relationships.

A one-to-one (1:1) relationship is an association between two entities. For example, in our culture, a husband is allowed on wife (at a time) and vice versa, and an employee has one social security number.

A one-to-many (I: M) relationship describes an entity that may have two or more entities related to it. For example, a father may have many children, and an employee may have many skills.

A many-to-many (M: M) relationship describes entities that may have many relationship in both directions, For example, children may have many toys, and students may have many courses.

Types of Data Structure

Data structuring determine whether the system can create 1:1, 1:M or M:M relationship among concerns. Although all DBMSs have a common approach to data management, many differ in the way they structure data. There are three types of data structure namely, hierarchical, network and relational.

Hierarchical Structuring

Hierarchical (also called tree) structuring specifies that an entity can have no more than one owing entity that is we can establish a 1:1 or 1: M relationship. The owing entity is called the parent; the owned entity, the child. A parent with no owners is called the root. There is only one root in a hierarchical model.

For example, a parent can have many children (1: M), whereas a child can have only one parent. Elements at the ends of the branches with no children are called leaves. Trees are normally drawn upside down, with the root at the top and the leaves at the bottom.

The hierarchical model is easy to design and understand. Some applications however, do not conform to such a scheme, such as for

a firm dealing in sale of spare parts being manufactured by more than one company. Thus, we would have a non-hierarchical structure, which complicates programming or the DBMS description. The problem is resolved by using network structure.

Network structuring

A network structure allows 1:1, 1:M, or M:M relationship among entities. For example; an auto parts shop may have dealings with more than one manufacturer (parent). Spare parts may come from two companies, so they are owned by both entities a structure that can best be supported by a network. Now consider the manufacturer and the auto parts shops it deals with. If the manufacturer sold spare parts to only one shop (say, a new car dealer), then there is a 1:1 relationship. If it supplied to many other dealers then there is a 1:M relationship. The 1:1 and 1:M relationship can be supplied by a hierarchy. When auto parts dealers are supplied by many manufacturers, however, there is an M:M relationship, which is a network structure.

A network structure reflects the real world, although a program structure can become complex. The solution is to separate the network into several hierarchies with duplicates. This simplifies the relationship to no more complex than 1:M. A hierarchy, then becomes a subview of the network structure.

Relationship Structuring

In relationship structuring, all data and relationships are represented in a flat, two-dimensional table called a relation. A relation is equivalent to a file, where each line represents a record. For example a relation that describes the entity EMPLOYEE by social security number, name and years with the firm. All the entries in each field are of the same kind. Furthermore, each field has a unique name. Finally, no two rows in the table are identical. A row is referred to as a tuple.

A relational DBMS has several features:

1. It allows the user to update (add, modify, of delete) the table's contents. Any position can be changed.

2. It provides inquiry capabilities against a label. Using our example, an inquiry might be. "How many years has Boynton been with the firm?" the response is '6".

3. Two or more tables can be merged to form one relation. Unlike hierarchical or network structuring where all relationship are predefined, a relational DBMS develops new relations on user commands.

4. A relationship structure is simpler to construct than a hierarchical or a network structure. It may be inefficient, though, since a relational DBMS responds to queries by an exhaustive review of the relations involved.

Entities and Attributes

An entity is something of interest to the user about which to collect or store data. It is also called a data aggregate because it represents a number of data elements. In our sales status system, the "sales" entity contains data elements such as the salesperson's number, name and date of employment, and the sales period covered by the report. The "item" entity has data elements such as item number, item description, and the sale price of each item.

Data entities are explained by the use of several terms: attribute, value key and instance of an entity. For example, a salesperson (entity) is described by attributes such a number, name, sex, age and height. So attributes describe an entity. They are physically stored in fields or data elements.

Each attribute takes on a unique value. For example, "11306801" is a unique value of the attribute "salesperson number." An attribute, then, takes on a value for a specific occurrence (or instance) of an entity.

A key is a unique identifier of the entity. In our example, the key 11306801 is a unique identifier of Jim Arnold. Sex, age and height are not identifiers, since they are not unique. They are non-key identifiers.

Normalization

Data structuring is refined through a process called normalization. Data are grouped in the simplest way possible so that later changes can be made with a minimum of impact on the data structure. When too many attributes are grouped together to form entities, some attributes are found to be entities themselves.

UNIT – V

LESSON NO. : 13

SOCIAL ASPECTS OF COMPUTERIZATION AND COMPUTER VIRUSES

The Internet and electronic commerce have awakened new interest in the ethical and social impact of information systems. Internet and digital firm technologies that make it easier than ever to assemble, integrate, and distribute information have unleashed new concerns about appropriate use of customer information, the protection of personal privacy, and the protection of intellectual property. These issues have moved to the forefront of social and political debate in the United States and many other countries.

Although protecting personal privacy and intellectual property on the Internet ate now in the spotlight, there are other pressing ethical issues raised by the widespread use of information systems. They include establishing accountability for the consequences of information systems, setting standards to safeguard system quality that protect the safety of the individual and society, and preserving and institutions considered essential to the quality of life in an information society. This lesson describes these issues and suggests guidelines for dealing with these questions, with special attention to the ethical challenges posed by the Internet.

Understanding Ethical and Social Issues Related To Systems

Ethics refers to the principles of right and wrong that individuals, acting as free moral agents, use to make choices to guide their behavior. Information technology and information systems raise new ethical questions for both individuals and societies because they create opportunities for intense social change, and thus threaten existing distributions of power, money, rights, and obligations. Like other technologies, such as steam engines, electricity, telephone, and

radio, information technology can be used to achieve social progress, but it can also be used to commit crimes and threaten cherished social values. The development of information technology will produce benefits for many, and costs for others. When using information systems, it is essential to ask, what is the ethical and socially responsible course of action?

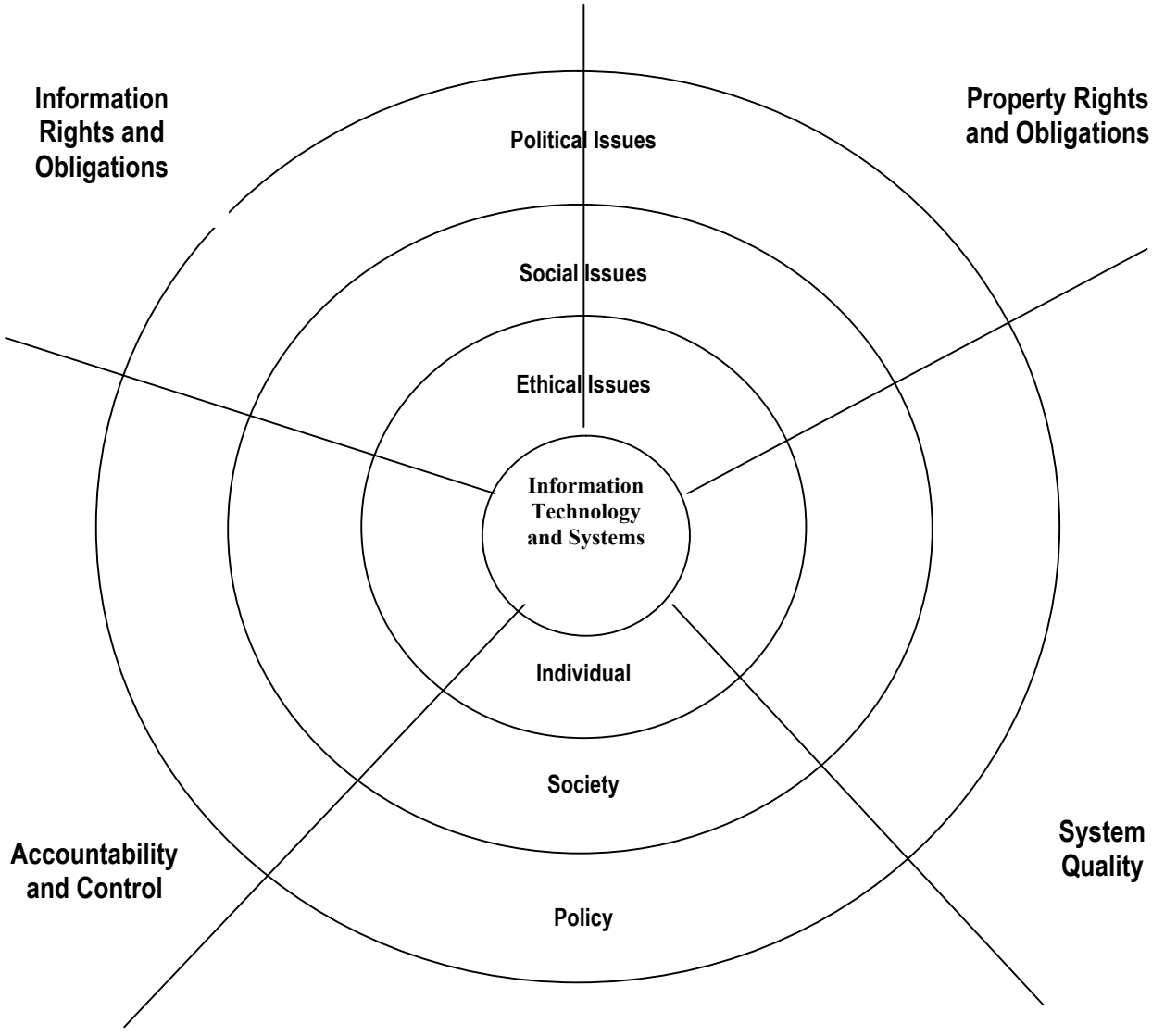


Figure 1 The relationship between ethical, social, and political issues in an information society. The introduction of new information technology has a ripple effect, raising new ethical, social, and political issues that must be dealt with on the individual, social, and political levels. These issues have five moral dimensions: information rights and obligations, property rights and obligations, system quality, quality of life, and accountability and control.

A Model for Thinking About Ethical, Social, and Political Issues

Ethical, social, and political issues are closely linked. The ethical dilemma faced by manager of information systems typically is reflected in social and political debate. One way to think about these relationships is given in Figure 1. Imagine society as a more or less calm pond on a summer day, a delicate ecosystem in partial equilibrium with individuals and with social and political institutions. Individuals know how to act in this pond because social institutions (family, education, organizations) have developed well-honed rules of behavior, and these are backed by laws developed in the political sector that prescribe behavior and promise sanctions for violations. Now toss a rock into the center of the pond. But imagine instead of a rock that the disturbing force is a powerful shock of new information technology and systems hitting a society more or less at rest. What happens? Ripples, of course.

Suddenly individual actors are confronted with new situations often not covered by the old rules. Social institutions cannot respond overnight to these ripples—it may take years to develop etiquette, expectations, social responsibility, "politically correct" attitudes, or approved rules. Political institutions also require time before developing new laws and often require the demonstration of real harm before they act. In the meantime, you may have to act. You may be forced to act in a legal "gray area."

We can use this model to illustrate the dynamics that connect ethical, social, and political issues. This model is also useful for identifying the main moral dimensions of the "information society," which cut across various levels of action—individual, social, and political.

MORAL DIMENSIONS OF THE INFORMATION AGE

The major ethical, social, and political issues raised by information systems include the following moral dimensions:

- Information rights and obligations: What information rights do individuals and organizations possess with respect to information about themselves? What can they protect? What obligations do individuals and organizations have concerning this information?
- Property rights: How will traditional intellectual property rights be protected in a digital society in which tracing and accounting for ownership is difficult, and ignoring such property rights is so easy?
- Accountability and control: Who can and will be held accountable and liable for harm done to individual and collective information and property rights?
- System quality: What standards of data and system quality should we demand to protect individual rights and the safety of society?
- Quality of life: What values should be preserved in an information and knowledge-based society? What institutions should we protect from violation? What cultural values and practices are supported by the new information technology?

Key Technology Trends That Raise Ethical Issues

Ethical issues long preceded information technology—they are the abiding concerns of free societies everywhere. Nevertheless, information technology has heightened ethical concerns, put stress on existing social arrangements, and made existing laws obsolete or severely crippled. There are four key technological trends responsible for these ethical stresses and they are summarized in Table 1.

The doubling of computing power every 18 months has made it possible for most organizations to use information systems for their core production processes. As a result, our dependence on systems and our vulnerability to system errors and poor data quality have increased. Social rules and laws have not yet adjusted to this dependence.

Standards for ensuring the accuracy and reliability of information systems are not universally accepted or enforced.

Advances in data storage techniques and rapidly declining storage costs have been responsible for the multiplying databases on individuals employees, customers, and potential customers;—maintained by private and public organizations. These advances in data storage have made the routine violation of individual privacy both cheap and effective. Already massive data storage systems are cheap enough for regional and even local retailing firms to use in identifying customers.

Advances in data analysis techniques for large pools of data are a third technological trend that heightens ethical concerns, because they enable companies to find out much detailed personal information about individuals. With contemporary information systems technology, companies can assemble and combine the myriad pieces of information stored on you by computers much more easily than in the past. Think of all the ways you generate computer information about yourself—credit card purchases, telephone calls, magazine subscriptions, video rentals, mail-order purchases, banking records, and local, state, and federal government records (including court and police records). Put together and mined properly, this information could reveal not only your credit information but also your driving habits, your tastes, your associations, and your political interests.

Table 1

Trend	Impact
Computing power doubles every 18 months	Mote organizations depend on computer systems for critical operations
Rapidly declining data storage costs	Organizations can easily maintain detailed databases on individuals
Data analysis advances	Companies can analyze vast quantities of data gathered on individuals to develop detailed profiles of individual behavior
Networking advances and the Internet	Copying data from one location to another and accessing personal data from remote locations are much easier.

Companies with products to sell purchase relevant information from these sources to help them more finely target their marketing campaigns. The use of computers to combine data from multiple sources and create electronic dossiers of detailed information on individuals is called profiling.

A new data analysis technology called non-obvious relationship awareness (NORA) has given both government and the private sector even more powerful profiling capabilities. NORA can take information about people from many disparate sources, such as employment applications, telephone records, customer listings, and "wanted" lists, and correlate relationships to find obscure hidden connections that might help identify criminals or terrorists. NORA technology can scan data and extract information as the data are being generated so that it could, for example, instantly discover a man at an airline ticket counter who shares a phone number with a known terrorist before that person boards an airplane. The technology could prove a valuable tool for homeland security but does have privacy implications.

Last, advances in networking, including the Internet, promise to reduce greatly the costs of moving and accessing large quantities of data, and open the possibility of mining large pools of data remotely using small desktop machines, permitting an invasion of privacy on a scale and precision heretofore unimaginable.

The development of global digital-superhighway communication networks widely available to individuals and businesses poses many ethical and social concerns. Who will account for the flow of information over these networks? Will you be able to trace information collected about you?

Ethics in an Information Society

Ethics is a concern of humans who have freedom of choice. Ethics is about individual choice: When faced with alternative courses of action, what is the correct moral choice? What are the main features of "ethical choice"?

Basic concepts: Responsibility, Accountability, and liability

Ethical choices are decisions made by individuals who are responsible for the consequences of their actions. **Responsibility** is a key element of ethical action. Responsibility means that you accept the potential costs, duties, and obligations for the decisions you make. Accountability is a feature of systems and social institutions. It means that mechanisms are in place to determine who took responsible action, who is responsible. Systems and institutions in which it is impossible to find out who took what action are inherently incapable of ethical analysis or ethical action. Liability extends the concept of responsibility further to the area of laws. **Liability** is a feature of political systems in which a body of laws is in place that permits individuals to recover the damages done to them by other actors, systems, or organizations. **Due process** is a related feature of law-governed societies and is a process in which laws are known and

understood and there is an ability to appeal to higher authorities to ensure that the laws are applied correctly.

These basic concepts form the underpinning of an ethical analysis of information systems and those who manage them. Information technologies are filtered through social institutions, organizations, and individuals. Systems do not have "impacts' by themselves. Whatever information system impacts exist are products of institutional, organizational, and individual actions and behaviors. Second, responsibility for the consequences of technology falls clearly on the institutions, organizations, and individual managers who choose to use the technology. Using information technology in a "socially responsible" manner means that you can and will be held accountable for the consequences of your actions. Third, in an ethical political society, individuals and others can recover damages done to them through a set of laws characterized by due process.

COMPUTER VIRUSES

A computer virus is a computer program that can infect other computer programs by modifying them in such a way as to include a copy of it. Note that a program does not have to perform outright damage (such as deleting or corrupting files) in order to be called a "virus".

Many people use the term loosely to cover any sort of program that tries to hide its (malicious) function and tries to spread onto as many computers as possible. Viruses are very dangerous. They are spreading faster than they are being stopped, and even the least harmful of viruses could be fatal. For example, a virus that stops a computer and displays a message, in the context of a hospital life-support computer, could be fatal. Even the creator of a virus cannot stop it once it is "in the wild".

Type of Computer Viruses

Generally, there are two types of viruses. The first type consists of the file infectors, which attach themselves to ordinary program files. These usually infect arbitrary .COM and/or .EXE programs, though some can infect any program for which execution is requested, such as .SYS, .OVL, .PRG, & .MNU files. File infectors can be either direct action or resident. A direct action virus selects one or more other programs to infect each time the program that contains it is executed. A resident virus hides itself somewhere in memory the first time an infected program is executed, and thereafter infects other programs when they are executed (as in the case of the Jerusalem 185 virus) or when certain other conditions are fulfilled. The Vienna virus is an example of a direct-action virus. Most other viruses are resident. The second category is system or boot-record infectors: those viruses that infect executable code found in certain system areas on a disk, which are not ordinary files. On DOS systems, there are ordinary boot-sector viruses, which infect only the DOS boot sector, and MBR viruses which infect the Master Boot Record on fixed disks and the DOS boot sector on diskettes. Examples include Brain, Stoned, Empire, Azusa, and Michelangelo. Such viruses are always resident viruses. Finally, a few viruses are able to infect both (the Tequila virus is one example). These are often called "multi-partite" viruses, though there has been criticism of this name; another name is "boot-and-file" virus.

File system or cluster viruses are those that modify directory table entries so that the virus is loaded and executed before the desired program is. The program itself is not physically altered; only the directory entry is. Some consider these infectors to be a third category of viruses, while others consider them to be a sub-category of the file infectors.

Stealth virus

A stealth virus is one that hides the modifications it has made in the file or boot record, usually by monitoring the system functions used

by programs to read files or physical blocks from storage media, and forging the results of such system functions so that programs which try to read these areas see the original uninfected form of the file instead of the actual infected form. Thus the viral modifications go undetected by anti-viral programs. However, in order to do this, the virus must be resident in memory when the anti-viral program is executed.

The very first DOS virus, Brain, a boot-sector infector, monitors physical disk I/O and redirects any attempt to read a Brain-infected boot sector to the disk area where the original boot sector is stored. The next viruses to use this technique were the file infectors Number of the Beast and Frodo.

Polymorphic virus

A polymorphic virus is one that produces varied (yet fully operational) copies of itself, in the hope that virus scanners will not be able to detect all instances of the virus. The most sophisticated form of polymorphism discovered so far is the MtE "Mutation Engine" written by the Bulgarian virus writer who calls himself the "Dark Avenger".

Fast and slow infectors

A typical file infector (such as the Jerusalem) copies itself to memory when a program infected by it is executed, and then infects other programs when they are executed. A fast infector is a virus which, when it is active in memory, infects not only programs which are executed, but also those which are merely opened. The result is that if such a virus is in memory, running a scanner or integrity checker can result in all (or at least many) programs becoming infected all at once.

The term "slow infector" is sometimes used for a virus that, if it is active in memory, infects only files as they are modified or created. The purpose is to fool people who use integrity checkers into thinking that the modification reported by the integrity checker is due solely to legitimate reasons. An example is the Darth Vader virus.

Sparse infector

The term "sparse infector" is sometimes given to a virus that infects only occasionally, e.g. every 10th executed file, or only files whose lengths fall within a narrow range, etc. By infecting less often, such viruses try to minimize the probability of being discovered by the user.

Companion virus

A companion virus is one that, instead of modifying an existing file, creates a new program, which gets executed by the command-line interpreter instead of the intended program. This is done by creating an infected .COM file with the same name as an existing .EXE file. Note that this type of malicious code is not always considered to be a virus, since it does not modify existing files.

Armored virus

An armored virus is one that uses special tricks to make the tracing, disassembling and understanding of its code more difficult. A good example is the Whale virus.

Macro virus

Many applications allow you to create macros. A macro is a series of commands to perform an application-specific task. Those commands can be stored as a series of keystrokes, or in a special macro language.

A macro virus is a virus that propagates through only one type of program, usually either Microsoft Word or Microsoft Excel. It can do this because these types of programs contain auto open macros, which automatically run when you open a document or a spreadsheet. Along with infecting auto open macros, the macro virus infects the global macro template, which is executed anytime you run the program. Thus, once your global macro template is infected, any file you open after that becomes infected and the virus spreads.

Virus hoax

A virus hoax generally appears as an email message that describes a particular virus that does not exist. These emails almost always carry the same basic story: that if you download an email with a particular subject line, your hard drive will be erased (an impossibility because the text of an email cannot harbor a virus).

Such messages are designed to panic computer users. The writer or writers email the warning and include a plea for the reader to forward it to others. The message then acts much like a chain letter, propagating throughout the Internet as individuals receive it and then innocently forward it. An example of a virus hoax is the "Good Times" virus — which was written in 1994 and since then has circled the globe many times over. The best thing to do on receipt of such an email is to ignore and delete it.

Major Virus Incidents Since 1998 Melissa

This virus set a benchmark the world over when it was first noticed on 26th March 1999. It was the fastest spreading virus. The Melissa virus is an automatic spamming virus. Its action includes infecting Microsoft Word's normal.dot global template, which basically implies that all new documents created by the user would get infected. After that, each time that an infected document is accessed the virus will disable Microsoft Word's macro warning feature so that it is allowed to be activated.

Its next action is to access Microsoft Outlook address book and e-mail the infected Word file as an attachment to the first fifty e-mail addresses entered there. As soon as the receivers of such an e-mail message open the attachment their computers also get infected. The virus then sends the infected file to another 50 e-mail addresses. This is the reason for the extensive spread of the virus in a short while.

The virus by itself, installed in the victim's computer, was rather harmless. It merely inserted some text into a document at a specified

time of the day. What caused the maximum harm was that the volume of traffic, due to the numerous e-mail attachments being sent, was more than could be borne by most servers around the world.

ExploreZip

In its activities it was similar to Melissa, but there was one major difference. ExploreZip, first discovered in June 1999, was not a virus. It was a Trojan. This means that it was incapable of replicating itself. Thus, the Melissa virus had more far reaching presence.

In addition to this dissimilarity, ExploreZip was more active. It not only hijacked Microsoft Outlook but also selected certain files and made their file size zero, reduced their data to nothing. Those files were then of no use to the user and they could not be recovered.

Chernobyl

The Chernobyl, or PE CIH, virus activates itself every year on the 26th of April - on the anniversary of the Chernobyl, Ukraine nuclear power plant tragedy. It was allegedly written by a Taiwanese citizen in 1998.

The virus wipes the first megabyte of data from the hard disk of a personal computer thus making the rest of the files of no use. In addition to this it also deletes the data on the computer's Basic Input-Output System (BIOS) chip so that the computer cannot function till a new chip is fitted or the data on the old one is restored. Fortunately only those BlOSes, which can be changed or updated, face a threat from this virus.

This virus affects only executable files. Since these are distributed less often than documents, the spread of Chernobyl is more confined than that of most macro viruses.

VBS_LOVELETTER

The VBS_LOVELETTER virus (better known as the Love Bug or the ILOVEYOU virus) was reportedly written by a Filipino

undergraduate. In May 2000, this deadly virus beat the Melissa virus hollow - it became the world's most prevalent virus. It struck one in every five personal computers in the world. When the virus was brought under check the true magnitude of the losses was incomprehensible. Losses incurred during this virus attack were pegged at US $ 10 billion, he original VBS_LOVELETTER utilized the addresses in Microsoft Outlook and e-mailed tself to those addresses. The e-mail which was sent out had "ILOVEYOU" in its subject line.

The attachment file was named "LOVE-LETTER-FOR-YOU.TXT.vbs". People wary of opening e-mail attachments were conquered by the subject line and those who had some knowledge of viruses, did not notice the tiny .vbs extension and believed the file to be a text file. The message in the e-mail was "kindly check the attached LOVELETTER coming from me". Since the initial outbreak over thirty variants of the virus have been developed many of them following the original by just a few weeks. In addition, the Love Bug also uses the Internet Relay Chat (IRC) for its propagation. It e-mails itself to users in the same channel as the infected user.

Unlike the Melissa virus this virus does have a destructive effect. Whereas the Melissa, once installed, merely inserts some text into the affected documents at a particular instant during the day, VBS_LOVELETTER first selects certain files and then inserts its own code in lieu of the original data contained in the file. This way it creates ever-increasing versions of itself.

Pakistani Brain

The Brain, the first virus known to have spread all over the world, was a boot sector virus. This implies that it would take the system commands, those that help in starting the computer, from their designated space (sector) on the hard disk and put them in the next unused space (sector). Then, it would mark the space where the system commands now reside as bad sectors. This way, it would become impossible to boot (start) the computer. Moreover, it would continue to

take up all the unused space in the computer's disk and mark it as corrupted sectors.

All the strains of the Brain virus carried the name of the program, the author and often their address in the boot sector of the virus-infected disk. The other known versions of this virus include Ashar or Ashar-Shoe viruses, which *are* very common in Malaysia.

Stoned-Marijuana

Originally reported to have been written in New Zealand, this was another boot sector virus with a difference. It would infect the boot sector of floppy disks. The File Allocation Table (FAT) on the hard disk drive - the system used by DOS to identify and locate files on a disk - would also be affected. The virus would most often regularly display a message, which said, "Your PC is stoned. Legalize Marijuana." Moreover, it would damage the File Allocation Table on hard disk drives with more than one partition. The FAT on floppy disks, which had been formatted as high density, would also be harmed so that access to files on both the hard disk and the floppy disk would become nearly impossible to achieve.

Jerusalem

The Jerusalem virus a.k.a. "Israeli" and "Friday the 13th" has several versions including the Jerusalem-B virus. It starts by infecting the .COM and .EXE files in a computer. After existing or being resident in a computer for half an hour, it slows down the system processes by a factor of ten. On a pre-set date, Friday the 13th, the Jerusalem virus deletes all the infected files from the user's computer. Apart from the damage that it does, the other strain of the Jerusalem virus, Jerusalem-B, also shows a "black window" in the center of the screen at regular intervals.

Cascade

The Cascade virus originally appeared between September and December during the years 1980 and 1988. Its basic target were

machines with colour monitors. This virus is also called "Falling Letters" or "1701". It initially appeared as a Trojan horse in the form of a program designed to turn off the Num-Lock light on the user's keyboard. In fact, what it actually did was to make the characters on the screen drop in a heap to the bottom of the screen. What is special about this virus is that it utilizes an encryption algorithm to evade detection. Now, variants of this virus occur as a memory resident .COM virus.

Michelangelo

The Michelangelo virus also referred to by some virus watchers as Stoned.Michelangelo, first spread in the early 1990's. Since then, a number of strains have been introduced, and it is now also known by a variety of other names. This virus was also responsible for the founder of Trend Micro entering the anti-virus business.

This virus was entitled after the very famous Italian Renaissance artist Michelangelo Buonarroti. It gets activated every year on the artist's birthday - 6th March. The person responsible for giving the name was the researcher not the writer of the virus.

The Michelangelo is a boot record virus and on the date that it gets triggered it destroys files by overwriting certain critical areas of the hard disk or floppy disk. These areas are overwritten with garbage, making the disk or floppy completely useless. If this virus infects a bootable floppy (a floppy that can be used to boot a computer), the floppy no longer remains a bootable floppy.

An infection with this virus is caused by using infected disks for a system boot-up. After being installed in the memory of the computer, Michelangelo then goes on to infect all nonwrite protected disks that are used in the computer.

UNIT – V

LESSON NO. : 14

COMPUTER CRIMES AND LEGAL ASPECTS

The first recorded cyber crime took place in the year 1820 That is not surprising considering the fact that the abacus, which is thought to be the earliest form of a computer, has been around since 3500 B.C. in India, Japan and China. The era of modern computers, however, began with the analytical engine of Charles Babbage.

In 1820, Joseph-Marie Jacquard, a textile manufacturer in France, produced the loom. This device allowed the repetition of a series of steps in the weaving of special fabrics. This resulted in a fear amongst Jacquard's employees that their traditional employment and livelihood were being threatened. They committed acts of sabotage to discourage Jacquard from further use of the new technology. This is the first recorded cyber crime.

Frequently Used Cyber Crimes

Unauthorized access to computer systems or networks

This activity is commonly referred to as hacking. The Indian law has however given a different connotation to the term hacking, so we will not use the term "unauthorized access" interchangeably with the term "hacking".

Theft of information contained in electronic form

This includes information stored in computer hard disks, removable storage media etc.

Email bombing

Email bombing refers to sending a large number of emails to the victim resulting in the victim's email account (in case of an individual)

or mail servers (in case of a company or an email service provider) crashing. In one case, a foreigner who had been residing in Shimla, India for almost thirty years wanted to avail of a scheme introduced by the Shimla Housing Board to buy land at lower rates. When he made an application it was rejected on the grounds that the 169 schemes was available only for citizens of India. He decided to take his revenge. Consequently he sent thousands of mails to the Shimla Housing Board and repeatedly kept sending e-mails till their servers crashed.

Data diddling

This kind of an attack involves altering raw data just before it is processed by a computer and then changing it back after the processing is completed. Electricity Boards in India have been victims to data diddling programs inserted when private parties were computerizing their systems.

Salami attacks

These attacks are used for the commission of financial crimes. The key here is to make the alteration so insignificant that in a single case it would go completely unnoticed. For example a bank employee inserts a program, into the bank's servers, that deducts a small amount of money (say Rs. 5 a month) from the account of every customer. No account holder will probably notice this unauthorized debit, but the bank employee will make a sizable amount of money every month.

To cite an example, an employee of a bank in USA was dismissed from his job. Disgruntled at having been supposedly mistreated by his employers the man first introduced a logic bomb into the bank's systems.

Logic bombs are programmes, which are activated on the occurrence of a particular predefined event. The logic bomb was programmed to take ten cents from all the accounts in the bank and put them into the account of the person whose name was alphabetically the last in the bank's rosters. Then he went and opened an account in the

name of Ziegler. The amount being withdrawn from each of the accounts in the bank was so insignificant that neither any of the account holders nor the bank officials noticed the fault.

It was brought to their notice when a person by the name of Zygler opened his account in that bank. He was surprised to find a sizable amount of money being transferred into his account every Saturday.

Denial of Service attack

This involves flooding a computer resource with more requests than it can handle. This causes the resource (e.g. a web server) to crash thereby denying authorized users the service offered by the resource. Another variation to a typical denial of service attack is known as a Distributed Denial of Service (DDoS) attack wherein the perpetrators are many and are geographically widespread. It is very difficult to control such attacks. The attack is initiated by sending excessive demands to the victim's computer(s), exceeding the limit that the victim's servers can support and making the servers crash. Denial-of-service attacks have had an impressive history having, in the past, brought down websites like Amazon, CNN, Yahoo and eBay!

Virus / worm attacks

Viruses are programs that attach themselves to a computer or a file and then circulate themselves to other files and to other computers on a network. They usually affect the data on a computer, either by altering or deleting it. Worms, unlike viruses do not need the host to attach themselves to. They merely make functional copies of themselves and do this repeatedly till they eat up all the available space on a computer's memory. 170 The VBS, LOVELETTER virus (better known as the Love Bug or the ILOVEYOU virus) was reportedly written by a Filipino undergraduate.

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personal computers in the world. When the virus was brought under check the true magnitude of the losses was incomprehensible. Losses incurred during this virus attack were pegged at US $ 10 billion.

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Logic bombs

These are event dependent programs. This implies that these programs are created to do something only when a certain event (known as a trigger event) occurs. For instance even some viruses may

be termed logic bombs because they lie dormant all through the year and become active only on a particular date (like the Chernobyl virus).

Trojan attacks

A Trojan as this program is aptly called, is an unauthorized program which functions from inside what seems to be an authorized program, thereby concealing what it is actually doing.

There are many simple ways of installing a Trojan in someone's computer. To cite and example, two friends Rahul and Mukesh (names changed), had a heated argument over on girl, Radha (name changed) whom they both liked. When the girl, asked to choose, chose Mukesh over Rahul, Rahul decided to get even. On the 14th of February, he sent Mukesh a spoofed e-card, which appeared to have come from Radha's mail account. The e-card actually contained a Trojan. As soon as Mukesh opened the card, the Trojan was installed on his computer. Rahul now had complete control over Mukesh's computer and proceeded to harass him thoroughly.

Internet time thefts

This connotes the usage by an unauthorized person of the Internet hours paid for by another person. In a case reported before the enactment of the Information Technology Act, 2000 Colonel Bajwa, a resident of New Delhi, asked a nearby net cafe owner to come and set up his Internet connection. For this purpose, the net cafe owner needed to know his username and password. After having set up the connection he went away with knowing the present username and password. He then sold this information to another net cafe. One week later Colonel Bajwa found that his Internet hours were almost over. Out of the 100 hours that he had bought, 94 hours had been used up within the span of that week. Surprised, he reported the incident to the Delhi police. The police could not believe that time could be stolen. They were not aware of the concept of time-theft at all. Colonel Bajwa's report was rejected. He decided to approach The Times of India, New Delhi. They, in turn

carried a report about the inadequacy of the New Delhi Police in handling cyber crimes. The Commissioner of Police, Delhi then took the case into his own hands and the police under his directions raided and arrested the net cafe owner under the charge of theft as defined by the Indian Penal Code. The net cafe owner spent several weeks locked up in Tihar jail before being granted bail.

Web jacking

This occurs when someone forcefully takes control of a website (by cracking the password and later changing it). The actual owner of the website does not have any more control over what appears on that website. In a recent incident reported in the USA the owner of a hobby website for children received an e-mail informing her that a group of hackers had gained control over her website. They demanded a ransom of 1 million dollars from her. The owner, a schoolteacher, did not take the threat seriously. She felt that it was just a scare tactic and ignored the e-mail. It was three days later that she came to know, following many telephone calls from all over the country, that the hackers had web jacked her website. Subsequently, they had altered a portion of the website which was entitled 'How to have fun with goldfish'. In all the places where it had been mentioned, they had replaced the word 'goldfish' with the word 'piranhas'. Piranhas are tiny but extremely dangerous flesh-eating fish. Many children had visited the popular website and had believed what the contents of the website suggested. These unfortunate children followed the instructions, tried to play with piranhas, which they bought from pet shops, and were very seriously injured.

Theft of computer system

This type of offence involves the theft of a computer, some part(s) of a computer or a peripheral attached to the computer.

Physically damaging a computer system

This crime is committed by physically damaging a computer or its peripherals.

E-mail related crimes

Email has fast emerged as the world's most preferred form of communication. Billions of email messages traverse the globe daily. Like any other form of communication, email is also misused by criminal elements. The ease, speed and relative anonymity of email has made it powerful tool for criminals.

Some of the major email related crimes are:

1. Email spoofing
2. Sending malicious codes through email
3. Email bombing
4. Sending threatening emails
5. Defamatory emails
6. Email frauds

Email spoofing

A spoofed email is one that appears to originate from one source but has actually emerged from another source. Falsifying the name and / or email address of the originator of the email usually does email spoofing, usually to send an email the sender has to enter the following information:

i. email address of the receiver of the email

ii. email address(es) of the person(s) who will receive a copy of the email (referred to as CC for carbon copy)

iii. email address(es) of the person(s) who will receive a copy of the email (referred to as CC for carbon copy, but whose identities

will not be known to the other recipients of the e-mail (known as BCC for blind carbon copy)

iv. Subject of the message (a short title / description of the message)

v. Message

Certain web-based email services like www.SendFakeMail.com, offer a facility wherein in addition to the above, a sender can also enter the email address of the purported sender of the email.

Consider Mr. Siddharth whose email address is siddharth@hotmail.com. His friend Golu's email address is golu@yahoo.com. Using SendFakeMail, Siddharth can send emails purporting to be sent from Golu's email account. All he has to do is enter golu@yahoo.com in the space provided for sender's email address. Golu's friends would trust such emails, as they would presume that they have come from Golu (whom they trust). Siddharth can use this misplaced trust to send viruses, Trojans, worms etc. to Golu's friends, who would unwittingly download them.

Spreading Trojans, viruses and worms

Emails are often the fastest and easiest ways to propagate malicious code over the Internet. The Love Bug virus, for instance, reached millions of computers within 36 hours of its release from the Philippines thanks to email. Hackers often bind Trojans, viruses, worms and other computer contaminants with e-greeting cards and then email them to unsuspecting persons Such contaminants can also be bound with software that appears to be an anti-virus patch. For instance, a person receives an email from Compose From To CC BCC Subject

Message

information@mcaffee.com (this is a spoofed email but the victim does not know this). The email informs him that the attachment contained with the email is a security patch that must be downloaded to detect a certain new virus. Most unsuspecting users would succumb to

such an email (if they are using a registered copy of the McAffee anti-virus software) and would download the attachment, which actually could be a Trojan or a virus itself.

Email bombing

Email bombing refers to sending a large amount of emails to the victim resulting in the victim's email account (in case of an individual) or servers (in case of a company or an email service provider) crashing. A simple way of achieving this would be to subscribe the victim's email address to a large number of mailing lists. Mailing lists are special interest groups that share and exchange information on a common topic of interest with one another via email. Mailing lists are very popular and can generate a lot of daily email traffic - depending upon the mailing list. Some generate only a few messages per day others generate hundreds. If a person has been unknowingly subscribed to hundreds of mailing lists, his incoming email traffic will be too large and his service provider will probably delete his account. The simplest email bomb is an ordinary email account. All that one has to do is compose a message, enter the email aaddress of the victim multiple times in the "To" field, and press the "Send" button many times. Writing the email address 25 times and pressing the "Send" button just 50 times (it will take less than a minute) will send 1250 email messages to the victim! If a group of 10 people do this for an hour, the result would be 750,000 emails. There are several hacking tools available to automate the process of email bombing. These tools send multiple emails from many different email servers, which makes it very difficult, for the victim to protect himself.

Threatening emails

Email is a useful tool for technology savvy criminals thanks to the relative anonymity offered by it. It becomes fairly easy for anyone with even a basic knowledge of computers to become a blackmailer by threatening someone via e-mail.

In a recent case, Poorva received an e-mail message from someone who called him or herself 'your friend'. The attachment with the e-mail contained morphed pornographic photographs of Poorva. The mail message said that if Poorva were not to pay Rs. 10,000 at a specified place every month, the photographs would be uploaded to the Net and then a copy sent to her fiance. Scared, Poorva at first complied with the wishes of the blackmailer and paid the first Rs. 10, 000. Next month, she knew she would have to approach her parents. Then, trusting the reasonableness of her fiance she told him the truth. Together they approached the police. Investigation turned up the culprit - Poorva's supposed friend who wanted that Poorva and her fiance should break up so that she would get her chance with him.

Defamatory emails

As has been discussed earlier cyber-defamation or even cyber-slander as it is called can prove to be very harmful and even fatal to the people who have been made its victims.

Email Frauds

Email spoofing is very often used to commit financial crimes. It becomes a simple thing not just to assume someone else's identity but also to hide one's own. The person committing the crime understands that there is very little chance of his actually being identified. In a recently reported case, a Pune based businessman received an email from the Vice President of the Asia Development Bank (ADB) offering him a lucrative contract in return for Rs 10 lakh. The businessman verified the email address of the Vice President from the web site of the ADB and subsequently transferred the money to the bank account mentioned in the email. It later turned out that the email was a spoofed one and was actually sent by an Indian based in Nigeria.

In another famous case, one Mr. Rao sent himself spoofed e-mails, which were upposedly from the Euro Lottery Company. These mails informed him that he had won the largest lottery. He also created

a website in the name of the Euro Lottery Company, announced n it that he had won the Euro Lottery and uploaded it on to the Internet. He then approached the Income Tax authorities in India and procured a clearance certificate from them for receiving the lottery amount. In order to let people know about the lottery, he approached many newspapers and magazines.

The media seeing this as a story that would interest a lot of readers hyped it up and played a vital role in spreading this misinformation. Mr. Rao then went to many banks and individuals and told them that having won such a large sum of money he was afraid for his safety. He also wanted to move into a better house. He wheedled money out of these institutions and people by telling them that since the lottery prize money would take some time to come to him, he would like to borrow money from them. He assured them that the loan amount would be returned as soon as the lottery money came into his possession. Lulled into believing him (all thanks to the Income Tax clearance) most of these people loaned large amounts of money to him. It was only when he did not pay back the loan amounts to the banks that they became suspicious. A countercheck by the authorities revealed the entire scheme. Mr. Rao was arrested. Later, it was found that some of the money had been donated for philanthropic causes and also to political parties!

Computer's Vulnerability

Computers, despite being such high technology devices, are extremely vulnerable. In fact it may be easier to steal national secrets from military computers than to steal "laddoos" from a "mithai" shop. Let us examine the reasons for the vulnerability of computers.

Computers store huge amounts of data in small spaces

Lakhs of pages of written matter can be stored in a CD ROM. Walking out of a godown with one lakh pages would be exceedingly

difficult, but walking out of a secure location with a CD ROM containing a lakh of pages would be much simpler.

Ease of access

A bank's vault, which usually contains a few lakh rupees is well guarded from unauthorized persons. The vault itself is made of very strong materials, located in a reinforced room, guarded by gun toting security personnel. Trusted employees jealously guard the keys and / or access codes. The bank's servers, on the other hand, which 'virtually' control hundreds of crores of rupees, are far easier to break into. The strongest of firewalls and biometric authentication systems have been cracked in the past and will probably continue to be cracked in the future. A secretly implanted logic bomb, key loggers that can steal access codes, advanced voice recorders, retina imagers etc. that can fool biometric systems can be utilized to get past many a security system.

Complexity

Operating systems are composed of millions of lines of code and no single individual can claim to understand the security implications of every bit of these computer instructions. Hactoa easily exploit the numerous weaknesses in operating systems and security products. Whetr one weakness is exposed and exploited openly by the 'black hat' community, the operating system (OS) manufacturer patches it up. The hackers then find another weakness to exploit and the cycle goes on and on. It is far easier to find weaknesses in existing operating systems rather than designing and developing a secure operating system.

Human error

People who guard confidential papers with their lives would not think twice about using simple passwords. Most people don't realize the security implications and ramifications of a simple 'guessable' password.

Information Rights'. Privacy and Freedom in the Internet Age

Privacy is the claim of individuals to be left alone, free from surveillance or interference from other individuals or organizations, including the state. Claims to privacy are also involved at the workplace: Millions of employees are subject to electronic and other forms of high-tech surveillance (Ball, 2001). Information technology and systems threaten individual claims to privacy by making the invasion of privacy cheap, profitable, and effective.

The claim to privacy is protected in the U.S., Canadian, and German constitutions in a variety of different ways, and in other countries through various statutes. In the United States, the claim to privacy is protected primarily by the First Amendment guarantees of freedom of speech and association, Fourth Amendment protection against unreasonable search and seizure of one's personal documents or home, and the guarantee of due process. The major U.S. federal statutes that set forth the conditions for handling information about individuals in such areas as credit reporting, education, financial records, newspaper records, and electronic communications. The Privacy Act of 1974 has been the most important of these laws, regulating the federal governments collection, use, and disclosure of information. At present, most U.S. federal privacy laws apply only to the federal government and regulate very few areas of the private sector.

Most American and European privacy law is based on a regime called Fair Information Practices (FIP) first set forth in a report written in 1973 by a federal government advisory' committee (U.S. Department of Health, Education, and Welfare, 1973). Fair Information Practices (FIP) is a set of principles governing the collection and use of information about individuals. FIP principles are based on the notion of a "mutuality of interest" between the record holder and the individual. The individual has an interest in engaging in a transaction,

and the record keeper—usually a business or government agency—requires information

In India, Information Technology Act was introduced in 2000. the salient features of this act are as follows:

The Information Technology Act, 2000 is an act to provide legal recognition for transactions carried out by means of electronic data interchange and other means of electronic communication, commonly referred to as electronic commerce, which involve the use of alternatives to paper-based methods of communication and storage of information, to facilitate electronic filling of documents with the government agencies and further to amend the Indian Penal Code, The Indian Evidence Act, 1872, the Banken's Books Evidence Act, 1891 and the Reserve Bank of India Act, 1934 and for matters connected there with or incidental there to. The act applies to whole of India and, save as otherwise provided in this Act, it applies also to any offence or contravention there under committed outside India by any person. The various terms in this are defined as under:

(a) "access" with its grammatical variations and cognate expressions means gaining entry into, instructing or communicating with the logical, arithmetical, or memory function resources of a computer, computer system or computer network;

(b) "addressee" means a person who is intended by the originator to receive the electronic record but does not include any intermediary;

(c) "adjudicating officer" means an adjudicating officer appointed under subsection (1) of section 46;

(d) "affixing digital signature" with its grammatical variations and cognate expressions means adoption of any methodology or procedure by a person for the purpose of authenticating an electronic record by means of digital signature;

(e) "appropriate Government" means as respects any matter,—

(i) Enumerated in List II of the Seventh Schedule to the Constitution;

(ii) relating to any State law enacted under List III of the Seventh Schedule to the Constitution, the State Government and in any other case, the Central Government;

(f) "asymmetric crypto system" means a system of a secure key pair consisting of a private key for creating a digital signature and a public key to verify the digital signature;

(g) "Certifying Authority" means a person who has been granted a licence to issue a Digital Signature Certificate under section 24;

(h) "certification practice statement" means a statement issued by a Certifying Authority to specify the practices that the Certifying Authority employs in issuing Digital Signature Certificates;

(i) "computer" means any electronic magnetic, optical or other high-speed data processing device or system which performs logical, arithmetic, and memory functions by manipulations of electronic, magnetic or optical impulses, and includes all input, output, processing, storage, computer software, or communication facilities which are connected or related to the computer in a computer system or computer network; SECI]

(j) "computer network" means the interconnection of one or more computers through—

(i) the use of satellite, microwave, terrestrial line or other communication media; and

(ii) terminals or a complex consisting of two or more interconnected computers whether or not the interconnection is continuously maintained;

(k) "computer resource" means computer, computer system, computer network, data,computer data base or software;

(I) "computer system" means a device or collection of devices, including input and output support devices and excluding calculators which are not programmable and capable of being

used in conjunction with external files, which contain computer programmes, electronic instructions, input data and output data, that performs logic, arithmetic, data storage and retrieval, communication control and other functions;

(m) "Controller" means the Controller of Certifying Authorities appointed under sub-section (1) of section 17;

(n) "Cyber Appellate Tribunal" means the Cyber Regulations Appellate Tribunal established under sub-section (1) of section 48;

(o) "data" means a representation of information, knowledge, facts, concepts or instructions which are being prepared or have been prepared in a formalised manner, and is intended to be processed, is being processed or has been processed in a computer system or computer network, and may be in any form (including computer printouts magnetic or optical storage media, punched cards, punched tapes) or stored internally in the memory of the computer;

(p) "digital signature" means authentication of any electronic record by a subscriber by means of an electronic method or procedure in accordance with the provisions of section 3;

(q) "Digital Signature Certificate" means a Digital Signature Certificate issued under subsection (4) of section 35;

(r) "electronic form" with reference to information means any information generated, sent, received or stored in media, magnetic, optical, computer memory, micro film, computer generated micro fiche or similar device;

(s) "Electronic Gazette" means the Official Gazette published in the electronic form;

(t) "electronic record" means data, record or data generated, image or sound stored, received or sent in an electronic form or micro film or computer generated micro fiche;

(u) "function", in relation to a computer, includes logic, control arithmetical process, deletion, storage and retrieval and communication or telecommunication from or within a computer;

(v) "information" includes data, text, images, sound, voice, codes, computer programmes, software and databases or micro film or computer generated micro fiche:

(w) "intermediary" with respect to any particular electronic message means any person who on behalf of another person receives, stores or transmits that message or provides any service with respect to that message;

(x) "key pair", in an asymmetric crypto system, means a private key and its mathematically related public key, which are so related that the public key can verify a digital signature created by the private key;

(y) "law" includes any Act of Parliament or of a State Legislature, Ordinances promulgated by the President or a Governor, as the case may be. Regulations made by the President under article 240, Bills enacted as President's Act under sub-clause (a) of clause (1) of article 357 of the Constitution and includes rules, regulations, bye-laws and orders issued or made thereunder;

(z) "licence" means a licence granted to a Certifying Authority under section 24;

(za) "originator" means a person who sends, generates, stores or transmits any electronic message or causes any electronic message to be sent, generated, stored or transmitted to any other person but does not include an intermediary;

(zb) "prescribed" means prescribed by rules made under this Act;

(zc) "private key" means the key of a key pair used to create a digital signature;

(zd) “public key" means the key of a key pair used to verify a digital signature and listed in the Digital Signature Certificate;

(ze) "secure system" means computer hardware, software, and procedure that—

(a) are reasonably secure from unauthorised access and misuse;

(b) provide a reasonable level of reliability and correct operation;

(c) are reasonably suited to performing the intended functions; and

(d) adhere to generally accepted security procedures;

(zf) "security procedure" means the security procedure prescribed under section 16 by the Central Government;

(zg) "subscriber" means a person in whose name the Digital Signature Certificate is issued;

(zh) "verify" in relation to a digital signature, electronic record or public key, with its grammatical variations and cognate expressions means to determine whether—

(a) the initial electronic record was affixed with the digital signature by the use of private key corresponding to the public key of the subscriber;

(b) the initial electronic record is retained intact or has been altered since such electronic record was so affixed with the digital signature.

SELF ASSESSMENT QUESTIONS

1. Write notes on

a) Cyber Crimes

b) Salient features of IT Act, 2000.