Madhya Pradesh Bhoj (Open) University, Bhopal
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मध्यप्रदेश भोज (मुक्त) विश्वविद्यालय, भोपाल

SELF - LEARNING MATERIAL

MBA, Second Year
Paper – IV

MANAGEMENT INFORMATION SYSTEM

MBA Second Year

Paper IV

MANAGEMENT INFORMATION SYSTEM

मध्यप्रदेश भोज (मुक्त) विश्वविद्यालय – भोपाल

MADHYA PRADESH BHOJ (OPEN) UNIVERSITY - BHOPAL

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SYLLABI-BOOK MAPPING TABLE

Management Information System

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INTRODUCTION

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Rapid globalization coupled with the growth of the Internet and information technology has led to a complete transformation in the way businesses or organizations function today. It has not only affected the management culture, but has also led to an increase in competition in terms of market and resources. Businesses have become more customer-driven and e-commerce is gaining popularity. Traditional means of correspondence have given way to online dealings, e-mails and chats.

With such a radical shift in the approach to doing business, came the need for a specialized system to handle the various departments and functions in an organization.

Management Information System or MIS can be called an organized and well-structured system put in place in an organization for the collection, storage, processing and dissemination of data in the form of information that helps the management in the smooth functioning of the organization.

This book, *Management Information Systems*, explains the concepts of MIS, its meaning, scope and role in modern management. It also deals with system analysis, input–output designs, the Internet and emerging technologies and how these have affected MIS; several data processing techniques, classification and implementation procedure of MIS and the organizational changes that have been brought about by the changing technologies associated with information system.

The book has been written in a self-learning manner. Every unit starts with the 'Objectives' that lays bare what the students would learn in that unit. This is followed by the 'Introduction' that gives a brief outline of the concept to be dealt with. 'Summary' and 'Key Terms' are given after every unit to help students recapitulate the concepts. The 'Check Your Progress' and 'Self-Assessment Questions and Exercises' sections in each unit help in better understanding the subject. The 'Further Reading' section creates a research interest in students for further exploration of the topics covered.

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UNIT 1 OVERVIEW OF MANAGEMENT, ORGANISATION AND MIS

Structure

1.0 Introduction
1.1 Objectives
1.2 Need for Information Systems
1.3 Basics of Information System
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1.5 Role and Scope of MIS in Modern Management
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1.0 INTRODUCTION

Information systems play an important role in management. Even though the study of information systems does not encompass the study of Information Technology (IT), information systems use IT extensively. Thus, some knowledge of IT is essential for the student. But first you will learn about the information needs of an organization and how this information is classified. You will learn how to acquire information, the nature of information and the various types of information. Then you will learn about information models and information management; two critical components of business operations. The present business trends point to the need for information management in business organizations. Systems are built to manage such information. These systems are housed on a computerized platform so that they deliver information in a timely and accurate manner. Information systems, as these are called, are designed to help organizations become more efficient by utilizing their resources to the maximum. Therefore, knowledge of systems concepts is important in itself. It is especially necessary while learning about information systems.

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Management Information Systems (MIS) deals with organizational functions and managers are people who drive an organization by planning its future, organizing and controlling its present and directing others in the organization to work towards a common objective. However, strictly speaking, in functional terms, management is all about taking decisions. In fact, the only quality which distinguishes a manager from the rest of the people in the organization is the manager's ability to take decisions. However, no decision can be taken in isolation. Even simple decisions require information as an input. These decision requirements fuel an insatiable need for information within the organization. This need for information is met by a set of information systems working in a synchronized manner, collectively called Management Information System (MIS). The competitive environment of today's business necessitates that MIS of any modern organization work on an information technology platform and suitable information be delivered to the right person at the right time.

In this unit, you will learn about need for information systems, basics of information system and introduction to Management Information System (MIS).

1.1 OBJECTIVES

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

- Understand information systems
- Appreciate the role of information systems in an organization
- Discuss about the meaning of Management Information Systems (MIS)
- Know about the role and scope of MIS in modern management
- Analyse the fundamental concepts of MIS
- Elucidate on computer-based MIS

1.2 NEED FOR INFORMATION SYSTEMS

Assessing the information needs of an organization for business execution is a complex task. The complexity can be handled if the information is classified on the basis of its use and application.

Information Needs/Classification of Needs of an Organization

The classification of information is as follows:

1. Organizational Information

Organizational information is the information that is required by departments and divisions of an organization. It may contain acount of the employees, products, services, and locations, the type of business, turnover and a variety of details of each one of these entities.

2. Functional Information

Functional information is the information required by functional heads to conduct management functions. This information is purely specific to that function and by

definition does not have a use elsewhere. Examples are purchases, sales, production, stocks, receivables, payables, outstanding, budget and statutory information.

Functional information is normally generated at equal time intervals, such as weekly, monthly or quarterly, for understanding the trends and making comparisons against the time scale. Such information is used for planning, budgeting and controlling operations. Functional information is used for assessing particular aspects of business, such as stocks of finished goods, receivables, and so on.

Functional information can be assessed on the basis of such parameters as work design, responsibility and functional objectives.

3. Knowledge Information

Knowledge information creates an awareness of those aspects of business which require the manager to think, decide and act. Such information shows the trends of an activity or a result against a time scale. For example, the trends in scale production technology, the deviations for budgets, targets norms, etc., competitor's information, industry and business information, plan performance and target and its analysis. This information is used by the middle and top management.

4. Decision Support Information

Decision support information is required by the middle and top management for decision-making. This information does not act as a direct input to the decision-making procedure or as a formula but supports the manager in decision-making.

Information is used in a decision support system for model building and problem solving. The support may act in two ways: one for justifying the needs of a decision and the other as an aid to decision-making. For example, information on a particular aspect such as utilization, profitability standards, requirement versus availability; information for problem solving and modeling; information on the business status; non-moving inventory, overdue payments and receivables.

5. Operational Information

Operational information is required by operational and lower level management. The purpose of this information is fact-finding and taking such decisions and actions that will affect the operations at a micro level. The source of operational information is largely internal. It is obtained by processing transactions. It is mostly current and relates to a small time span.

6. Strategic Information

Strategic information is required for long-term planning and for directing the course the business should take.

7. Tactical Information

Tactical information is required to take short-term decisions to run the business efficiently. It requires specifically designed processing of data. Most of it can be obtained from day-to-day collection of routine data.

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Determining Information Requirement

The main purpose of a business information system is to produce such information that will reduce uncertainty in a given situation. The difficulties in determining a correct and complete set of information are as follows:

- The capability constraint of the human being as an information processor, a problem solver and a decision-maker.
- The nature and variety of information.
- Reluctance of decision-makers to spell out the information for political and behavioural reasons.
- The ability of the decision-makers to specify the information.

Methods of assessing Information Needs

The four methods of assessing information needs are:

1. Asking or interviewing
2. Determining from the existing system
3. Analysing critical success factors
4. Experimenting and modelling

1. Asking or interviewing

In this method, an MIS designer converses with the user of the information to determine information requirements.

2. Determining from the existing system

Existing systems have evolved after a number of years of usage. They are fairly useful in determining the information requirements of an organization. Sometimes, information systems of other organizations can also come in handy in determining information requirements.

3. Analysing critical success factors

For each organization, there are critical factors which determine its performance. Analysing these factors can give a valuable insight.

4. Experimenting and modelling

Where there is total uncertainty, the designer and the user of the information resort to experimentation to determine information requirements. This would decide the methodology for handling situations. Information needs are determined after a method has been finalized as these methods have evolved through experimentation. Test marketing of a product is an example of this approach.

Nature of Information

Information is nothing but refined data. That is, data that has been put into a meaningful and useful context and communicated to a receiver who then uses it to take decisions. As a corporate resource, its nature can be defined by the following characteristics:

1. Information is meant to be shared by all those who are associated with the attainment of the company's common goals and they, in turn, contribute to the corporate stock of information.

2. Most of the information is organization specific and its value depends upon its use by the decision-maker.
3. It has a high rate of obsolescence and thus must reach the user as early as possible. Redundant part of this resource must be weeded out of the total stock of information.
4. Information is exposed to a variety of security risks. Therefore, appropriate security policies and procedures should be implemented to protect information such that these do not hinder the informations's seamless flow.
5. Information is a value added resource. Just as value is added to a product as it moves from the raw material stage to the final stage, the same is true for converting data into information.
6. Information has a specific cost associated with it just as if it were acquired from a market. Therefore it is essential to acquire and utilize information efficiently.

1.3 BASICS OF INFORMATION SYSTEM

Information Systems (IS) are a special class of systems that are used for data storage, retrieval, processing, communication and security. Information systems that help management at different levels to take suitable decisions are called Management Information Systems (MIS). Information systems are housed in a computerized environment / platform to enable users to get accurate information immediately.

Information Systems: Definition and Characteristics

According to Orlikowski (1992), 'Nothing is more central to an organization's effectiveness than its ability to transmit accurate, relevant, understandable information amongst its employees. All the advantages of an organization's economy of scale, financial and technical resources, diverse talents, and contacts are of no practical value if the organization's employees are unaware of what other employees require of them.'

Information systems over the years

Information systems have transformed remarkably in the last forty years of their existence. Initially, information systems were designed to perform a specific task quickly with very few errors. The concept of using information systems to take decisions had not been thought of earlier. Organizations used information systems only for data processing, be it salaries or bills. Those who worked on these systems were familiar with the commands and the interface, which was character based. The output was in the form of salary slips, bills and invoices. These were data processing systems. These systems used file-based data storage systems on which a programme would work, i.e., the programme would be able to access the data and organize it, but it would store the data in a file. The problem with this type of system is that it leads to replication of data and loss of consistency.

Over the years, information systems have changed. Now the focus is on helping management by providing information useful for decision-making. Data processing systems have become obsolete. Delivering the right information to the right people at the right time is the priority. Information systems have become

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faster, more accurate and user friendly. Those who work on information systems nowadays know little about systems. They are normal users. New concepts, such as client server architecture, networking, distributed computing, centralized database, graphical user interface and the Internet, have emerged in the information systems space to help organizations get better value for their money. Bulky and expensive mainframe systems have been replaced by expensive software.

Information Systems: Components, Applications and Types

Information systems are data processing systems, which collect data from different sources, process that data and generate information from the data which can further be used for different applications within the organization. For example, in a business context, an information system collects data from various systems such as finance and sales systems from the supplier side. The information system processes the data and generates information for the customer. Customers provide feedback to the supplier depending on the information processed by the information system. Figure 1.1 shows the information system in a business context.

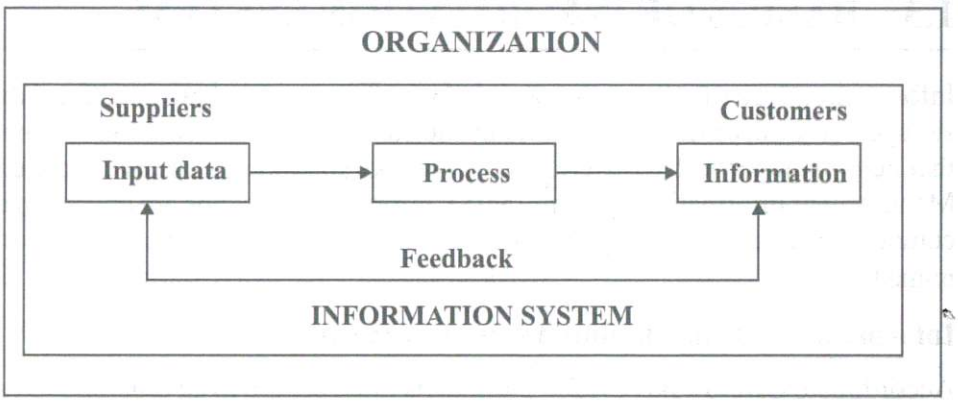

Fig. 1.1 *The Information System in a Business Context*

Information systems are basically systems that help to maintain and manage information. An information system helps to manage and store information to perform various functions such as decision-making, documentation of business activities and generation of reports for analysis of organizational operations. One needs to understand the concept of information and system to acquire a basic knowledge of information systems. Various terms used in information systems are as follows:

- *Data* is the raw material that can be a number, a fact, a sound, a picture or a statement gathered from different sources. In the real world, data can represent anything related to business processes and employee details.
- *Information* is meaningful data or processed data. It defines the relation between the different data.
- *System* is refers to a collection of components that helps in achieving a common objective. For example, in a human–machine system, the machine element consists of hardware and software to perform computation, and people make decisions based on this computation.

Components of information systems

A system consists of two types of components: abstract system components and physical system components. Abstract system components perform such operations as collecting input data, processing the data and generating information from that data. Physical system components consist of various elements such as hardware, software and human resources. There are a few more components of an information system, such as:

- **Data**: Input that the system takes to produce information.
- **Hardware**: A computer and its peripheral equipment such as input, output and storage devices.
- **Software**: Application programs or a set of instructions that process the input data using computers, generate information and store information for future use.
- **Network**: A collection of computer systems connected to each other to share the information.
- **Manpower**: Information system professionals and users who perform various organizational operations such as analysis of information, designing and construction of the information system, and maintenance of the information system. The workforce could comprise IT experts, managers and workers.
- **Graphical User Interface (GUI)**: This is an interface for the users of an information system to work with information on the computer system. A user can operate, process and retrieve information from the computer storage using GUI.

The components of an information system describe the functioning of the system. An information system takes the input data from the users of the information system to perform business operations. The users interact with the computer to process data using GUI. After processing data, information is retrieved at the users' end. Figure 1.2 shows the basic information system to perform business operations.

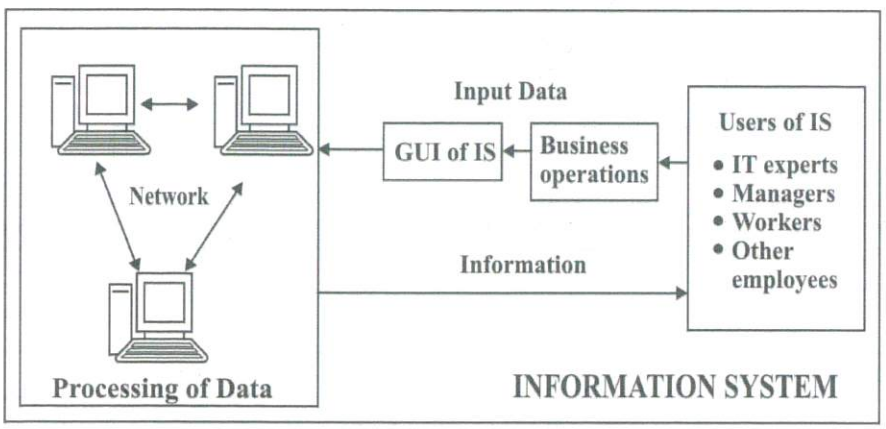

Fig. 1.2 The Basic Information System

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Applications of information systems

There are many application areas that implement information systems in a business environment to solve business problems and to pursue business opportunities. Figure 1.3 shows the various application areas of information systems in an organization.

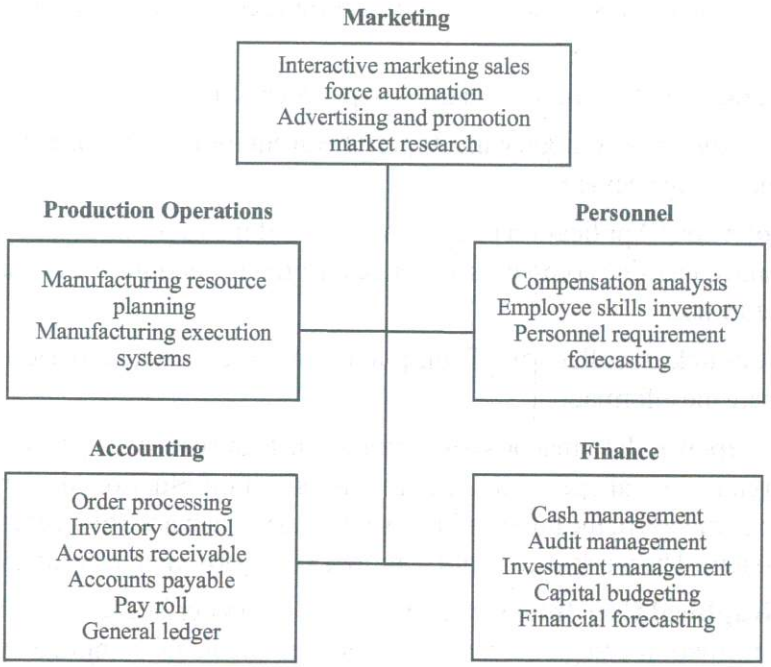

Fig. 1.3 The Application Areas of Information Systems

Types of information systems

Information systems manage data and process it to provide operational and managerial support in an organization. Operations-support systems control business operations, generate sales orders and determine payment to the employees. Management-support systems help to take managerial decisions for the development of the organization. Figure 1.4 shows the classification of information system.

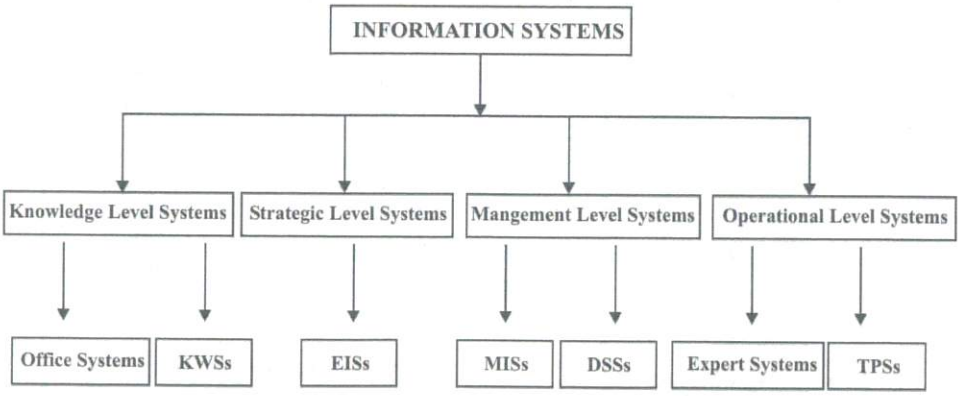

Fig. 1.4 The Classification of Information Systems

Organizations use different types of information systems as per the requirements of organizational functions. Various types of information systems on

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the basis of organizational functions that help in integrating business processes and information are as follows:

- Management Information System (MIS) which manages the information to plan and control the organizational tasks and to make decisions.
- Decision-Support System (DSS) which supports the low-level and the middle-level workers to take decisions for a better performance of the organizational functions.
- Executive Information System (EIS) which helps top business executives in decision-making using key business information.
- Expert Systems which analyse business information and provides solutions to those business problems already defined in its implementations.
- Knowledge Work System (KWS) which takes inputs as designing specifications, models them and generates pictures and graphics. The output of the system helps technical staff and professionals to understand the business operations visually. KWSs generate, share and distribute knowledge and help in decision-making.
- Transaction Processing System (TPS) which is an essential business system that assists the functional plane. An inbuilt system, it plays a vital role in the execution and documentation of routine dealings for the smooth running of the business.
- Office Systems (OS) which helps to keep records and manage various office operations such as accounting and sales. These systems process word documents and generate electronic information.

Different types of information systems are used for different types of functions. For example, an EIS is used for strategic planning. Strategic planning helps to take decisions for future plans. Figure 1.5 shows various types of information systems, their functions and the level of the system in which they are used.

TYPES OF SYSTEMS	Strategic-Level Systems				
Executive Support Systems (ESS)	5-year sales trend forecasting	5-year operating plan	5-year budget forecasting	Profit planning	Personnel planning
	Management-Level Systems				
Management Information Systems (MIS)	Sales management	Inventory control	Annual budgeting	Capital investing analysis	Relocation analysis
Decision-Support Systems (DSS)	Sales region analysis	Production scheduling	Cost analysis	Pricing/profitability analysis	Contract cost analysis
	Knowledge-Level Systems				
Knowledge Work Systems (KWS)	Engineering workstations		Graphics workstations		Managerial workstations
Office Systems	Word processing		Document imaging		Electronic calenders
	Operating-Level Systems				
Transaction Processing Systems (TPS)	Order tracking	Machine control	Securities trading	Payroll	Compensation
		Plant scheduling		Accounts payable	Training and development
	Order processing	Material movement control	Cash management	Accounts receivable	Employee record keeping
	Sales and Marketing	Manufacturing	Finance	Accounting	Human Resources

Fig. 1.5 *Various Types of Information Systems, their Levels and Functions*

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Information Models

An information model is a formal representation of any particular entity, be it a project, an object or a system. It includes the entity's various features and characteristics, functions and interrelations. An information model represents all the concepts, rules, operations, limits and specifications to represent data in a stable, sharable and organized structure. A mapping of an information model is called a data model.

Facility Information model

A facility information model is a model of a facility, with integrated data and documents. A facility is something that can be designed, fabricated, constructed and installed, operated, maintained and modified. Examples of a facility include an infrastructural network, a building, a process plant, a highway, a plane or a ship. It is different from a product model, which is typically expressed as a data structure. A facility information model on the other hand, can integrate more than 1000 components and a large number of documents. It is useful to those who want information about the components of a facility and their operations.

A facility information model can be a fixed data model or can be expressed in a flexible modelling language such as Gellish English.

A facility information model may consist of the following:

- A facility model with processes and activities
- A documents and data sets section
- An electronic common dictionary
- Requirements models

Facility Model

A facility model describes a facility in a hierarchical structure. It is divided into sections, which in turn are broken into units and utilities. These are further divided into equipment systems, subsystems and control loops, which are broken into components of equipments. It comprises data in the form of relations between the components and their properties and relations to other objects.

Documents and data sets

Each document and data set is related to a particular element in the facility model.

Electronic common dictionary

All the components, data and documents are classified and defined in an electronic common dictionary, which is an integral part of a facility information model.

Requirements models

The requirements of a facility information model are defined in computer-interpretable ways to measure its quality.

Integrating the information model with the data processing system

The primary function of an information system is to manage large quantities of data, which can be both structured or unstructured. Data models depict structured data so they can be stored in data management systems. Unstructured data like e-mails, word processing files, digital audio, video and images are generally not depicted.

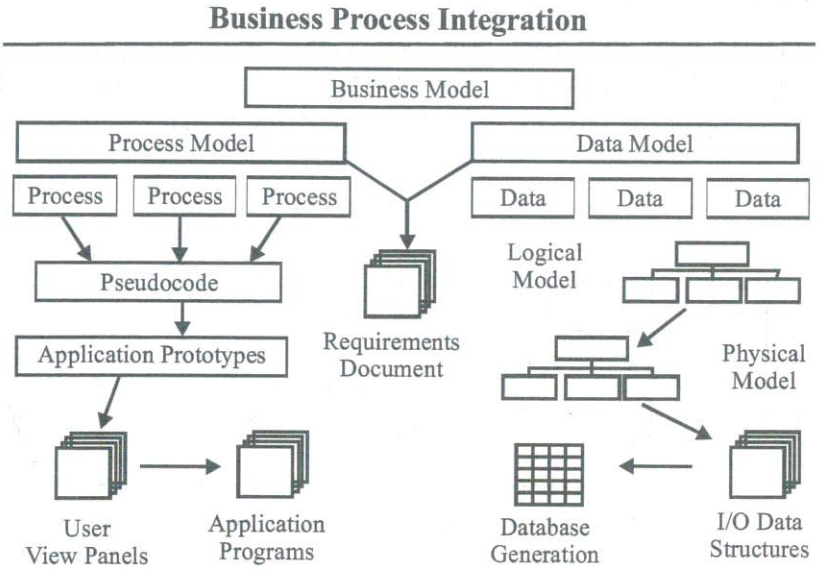

Fig. 1.6 Business Process Integration

The integration of data processing system and information model illustrates the functions associated with a process and the organizations that perform these functions.

Role of data models

Data models provide a data's definition and format and support data and computer systems. Data can be compatible if this is done consistently across all systems. Different applications can share the same data if the same data structures are used. Some of the drawbacks of data models are:

- Small changes in business operations require major changes in computer systems.
- Sometimes, entity types are wrongly identified, or not identified at all, leading to duplication at all levels, with attendant costs.
- Different systems can have different data model. Complex and costly interfaces are required in such cases to share data.
- Not all data can be shared electronically due to their inherent structures.

The main cause for these drawbacks is lack of standards for data models.

Information modelling and business orientation

Information models are a major component of enterprise content management, and dynamic content management. Business Information Modeling (BIM) provides

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a structure describe the business under consideration from an information perspective. BIM breaks down a business into its basic components and identifies information-processing requirements.

An understanding of the flow of information throughout an organization provides a foundation for identifying opportunities for automation that can add significant value to companies, especially in reducing costs, improving quality, increasing revenues and enhancing customer service.

A BIM is often divided into primary functions, the functions that are required to develop and deliver a company's products or services; and support functions, which the company requires to perform to support the primary functions.

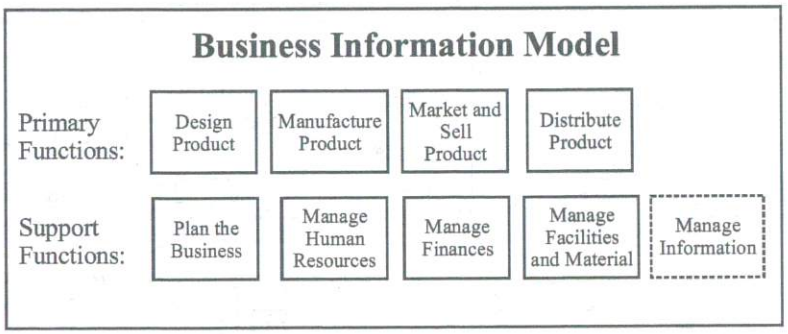

Fig. 1.7 A Business Information Model

BIM serves as a framework to document business processes. It also the depicts the data that a company requires for its business processes, and, in turn, the data that is produced by these processes. These processes have to be documented in process models. The data used by each process should be standardized and documented in data models.

Information Management (IM)

Information Management (IM) comprises the compilation and management of information from various sources and the sharing of that information with audiences. Till about the 1970s, this was limited to maintaining paper-based files, folders and records. With the revolution of information technology or IT from the 1980s onwards, information management started taking the shape of data maintenance. Skilled professionals and experts at hardware and software, were now required for the tasks of information management. By the late 1990s, network managers became information managers.

Information Concepts

We will now look at some concepts related to information, that is, data, information and knowledge.

Data

Data refers to the basic facts and entities such as names and numbers. Examples of data are dates, weights, prices, costs, numbers of items sold, employee names, product names, addresses, tax codes, registration marks, etc.

Data is collected, stored and processed in a way so that it can be used to arrive at specific conclusions.

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In a business, data input is a collection of facts about elements, such as consumers, suppliers, competitors and government. Data refers to the raw materials consumed in production processes, that used in factories or industries.

Information

Information is data that has been converted into a more useful form. Information is used for direct utilization of mankind, as it helps human beings in their decision-making process, for example, time tables, merit lists, report cards, headed tables, printed documents, pay slips, receipts, reports, etc.

Information is obtained by assembling items of data into a meaningful form. Other forms of information are pay-slips, schedules, reports, work sheets, bar charts, invoices and account-returns. Information may further be processed and/or manipulated to form knowledge.

Knowledge

Knowledge is a hierarchy of reliable data and information that is used to service work and decisions. Its consolidation creates an intangible wealth for all purposes. A small difference exists between data, information and knowledge. Data is raw facts and numbers. Information is the result of processing data to give it meaning. An accumulation of relevant information is called knowledge.

There are two types of knowledge:

1. Explicit: Explicit knowledge which can be attained from reading a document.
2. Tacit: Tacit knowledge is shared from an individual's experience through dialog, judgement, lessons, etc. It is not easily transferable.

In a competitive market where every organization is primarily using innovation as a tool for competitive advantage, knowledge combined with a good strategy helps promot innovation.

Data in itself, especially raw data in large quantities, is of very little use or rather no use to decision-makers within an organization. It is too difficult for a single or a group of persons to look at a set of data and extract some meaning from it. Figure 1.8 shows the process of using data, information and knowledge in order to make organizational decisions.

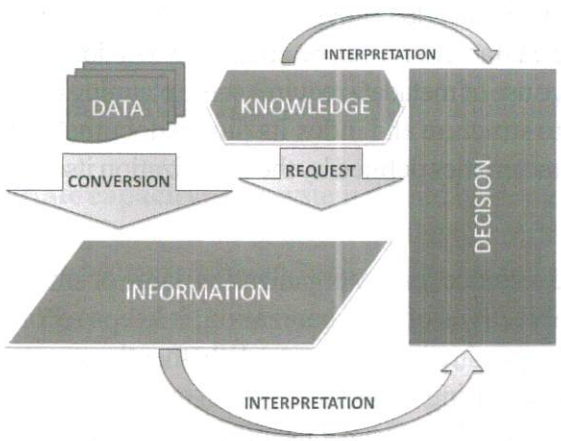

Fig. 1.8 The Process of Data, Information and Knowledge

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Classification of data

For data management purposes, data is classified into two categories: (i) structured and (ii) unstructured data.

(i) Structured Data

Structured data or structured information is the data stored in fixed fields within a file or a record. This form of data representation is also known as tabular data, where data sets are organized in the form of a table. Structured data is managed by techniques that work on query and reporting against programmed and stored data types and relationships. Databases and spreadsheets are examples of structured data.

(ii) Unstructured Data

People use and create unstructured data everyday, although they may not be aware of the same. A word processed letter or e-mail, in fact documents, and images such as those captured by a digital camera are all examples of unstructured data. Unstructured data primarily consists of textual data and image data. Textual data being any string of text, this could be a whole book or simply a short note. Images are digital pictures such as photographs and maps.

In business, unstructured data can take the form of letters, memorandums, reports and legal documents. In order to manage this data effectively it needs to be organized for storage and retrieval, because the information in these documents may be critical to business processes. One technique for organizing or structuring unstructured data is to utilize metadata.

Metadata

In its simplest definition, metadata is *'data about data.'* Metadata about a document could include:

- Author or source
- Date written
- Document category
- Document content
- Number of pages, words, data entries, etc.

The use of metadata does not require one to follow any rules or protocol. Any conceivable characteristic can be attributed to a document or a set of data, though an effective use of metadata requires some planning and foresight. It allows an organization to structure and index its digital document resources based on categories or characteristics defined by the organization itself.

Managing data

Data is a valuable resource for any organization, large or small. Regardless of the operations and objectives of an organization, it keeps records of its finances, employees, stocks, production, and so on. Whether these records are stored and updated electronically using a computer system or on paper using a filing cabinet, an organization will benefit by managing this data effectively.

Recording and storing data within an organization is only useful if this data is used to benefit the firm. Unused data, apart from the legal requirements of record keeping, is generally considered a wasted resource. Data on stock control and production output in a manufacturing firm can be analysed to identify strengths and weaknesses in the production process, employee records can help identify trends and information regarding salary and demographics can help focus development on the workforce. These and many more such benefits can be achieved by managing an organization's data.

At its most basic level, managing data is about organizing an environment or system where data can be stored, updated and retrieved. An organization's data management requirements will be greater than the aforementioned and its specific requirements will be more complex. Standard requirements of data management within an organization are as follows:

1. **Outline the organization's objectives:** What does the organization want to achieve through data management? What systems and processes are already in place? What are the remaining requirements to fulfill these objectives?

   These are questions an organization needs to ask before implementing a data management strategy or changing the way it manages data. Every organization is different and, therefore, the requirements of data management are also different. One objective may be to use a decision support system that utilizes data from three different departments in order to help focus the organizational goals and improve business processes. This objective can be broken down into technical requirements and specifications. By doing the same with all identified objectives, the organization can quickly view its total requirements to achieve all its objectives related to data management.

2. **Provide a data storage solution:** This involves designing and implementing an appropriate system for the organization to store its data. It usually, but not always, involves a database system. The storage solution should fulfil the following basic requirements:

   - **Security:** The storage system should not be accessible to outsiders. Sensitive data should only be made available to appropriate persons, departments or systems within the organization.
   - **Easily updatable:** The system should allow updation of records and addition of new data quickly and easily.
   - **Easy retrieval of data:** The system should allow data to be retrieved quickly and easily.
   - **Appropriate capacity:** The system should be designed such that its capacity is large enough for both current and future data requirements. It should also be upgradable and expandable for future needs.
   - **Backup:** There should be an appropriate backup system in place in order to recover data should there be a critical failure or event. The more often a system updates and alters data, the more often backups should take place.

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To summarize, a poor data management strategy can at best provide the basic functions for storing and updating organizational data and at worst become a security risk for sensitive data. A good data management strategy allows an organization to utilize data to increase its effectiveness. Developing and implementing an effective data management system can be costly. However, for most organizations the benefits far outweigh the costs.

Data management in IT

From the very moment a computer was used to make calculations involving data, the need to store and access this data was identified and the following solutions were developed: File System was developed in the 1950's followed by hierarchical Data Base Management Systems (DBMS) in the 1960's. Network DBMS, followed by Relational DBMS were developed in the 1970's and later on developed into Object-oriented DBMS in the 1990's.These concepts will be examined in the following sections.

Dimensions of information

Information can have different dimensions, broadly categorized under business and technical dimensions.

Business dimensions

This dimension relates to the business angle of information and its value to the organization. The sustainability of getting information from a managerial standpoint, the accuracy and reliability of information and its scope and appropriateness, are the parameters for understanding the business dimension of information. This dimension has got more to do with the 'what' of the information rather than the 'how.' The business dimension of information can have the following parameters:

- **Time:** Information has to be timely to be of any value.
- **Accuracy**: Information has to be accurate to satisfy the user.
- **Reliability:** Information has to be reliable, so that users have confidence.
- **Appropriateness:** Information must be relevant to the receiver. It must be appropriate to his needs.
- **Scope:** Information should be within the user's scope.
- **Completeness of Content:** Information should be complete and not in bits and pieces.

Technical dimensions

The technical dimension relates to the gathering, summarizing, storing and retrieval, analysis and cost aspects of information. It can have the following parameters:

- Information gathering
- Analysis methodology
- Technological issues
- Networking and communication
  - Data management and maintenance
  - Visualization and reporting

- Costs of information
- Cost of data acquisition
- Cost of data maintenance
- Cost of data access

Role of Information in Decision-Making

Decision-making is a process that includes the following stages:

- **Identification and structuring of problems:** One needs information to identify a problem and describe it in a structured manner.
- **Putting the problem in a context:** Without information about the context in which the problem has occurred, one cannot take any decision on it. In a way the context defines the problem.
- **Generation of alternatives:** Information is a key ingredient in the generation of alternatives for decision-making.
- **Choice of the best alternative:** Based on the information about the suitability of the alternatives, a choice is made to select the best alternative.

Information is required to take decisions. Imagine a simple decision like the one a driver makes, when he presses the brakes to stop his speeding vehicle, a child crossing the road. The driver decides on braking based on the information processing that occurs in his brain. At every stage, he uses information, which he captures visually. All decisions are like this.

First we get information about a problem, which we format into a structure. Then we get information about the context in which the problem has occurred. In the example described above, if, instead of the child crossing the road, the driver had seen the child about to cross over with a few steps only, he would not have braked to stop but would have slowed down, as he would have calculated that by the time the vehicle reached the crossing stage, the child would have passed. If the problem was described as 'how not to hit the child crossing the road', and if the child was in the middle of the road, the driver would have braked but had the child been about to complete crossing the road, the driver would have only slowed down and not braked to stop. Therefore, we see that context has a major role in decision-making and information is required both about the problem and about the context in which the problem occurred.

The next stage for the decision-maker would be to generate alternatives. In the driver's case, such alternatives would be to:

(a) Stop by braking.
(b) Slow down.
(c) Take a sharp turn towards the left or right to avoid the child.
(d) Press the horn so that the child crosses the road quickly.
(e) Drive the vehicle on to the footpath and out of the road to avoid collision.

So the decision-maker generates these possible solutions to the problem at hand, based on the knowledge and information he has. For instance, in the example discussed above, the driver would need to know that braking stops the vehicle. If

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he is unaware of this crucial information he would not be able to generate this alternative.

To decide which alternative to choose, the decision-maker needs to know what would be suitable. In our example, the driver calculates the payoff for each alternative, based on his calculation of the outcome, which again is based on information. He selects the best option to solve the problem. Thus, we can see that information is the key to the decision-making process. Without information and the right kind of information, decision-making is not possible.

Therefore, to enable managers to take good quality decisions, it is very important to provide them with the right kind of information. An MIS provides this service to the managers, enabling them to take informed decisions.

Subsystems of an Information System

An information system allows the storage, retrieval and processing of data in a secure environment. Logically, the subsystems of an information system are:

- **Data repository**: This is a subsystem that is at the core of any information system. This is a relational database management system (RDBMS) that includes preformatted and structured tables for storage of data. These structures are arranged in a way that helps in the faster storage and retrieval of such data with adequate security.
- **User interface**: This subsystem handles the interaction of the system with the user and hence it has to take care of issues related to the display of data on an output medium. This can be either graphical or character-based depending on the level of ease offered to the user.
- **Network**: This subsystem ensures communication between the different entities of an information system. It is crucial for the functioning of an information system.
- **Computer hardware**: IT infrastructure is necessary to use information systems in an effective manner. Almost all the components of an information system are housed in some kind of computer hardware to enable it to perform tasks faster. For example, an algorithm to find the lowest of three numbers can be calculated manually but under a computerized system it will be much faster and efficient.
- **System software**: Some basic software is required for an information system to function efficiently. System software enables information systems. Examples would include operating systems.
- **Input/output**: Sometimes, this is clubbed with the user interface to suggest that I/O functions are handled by UI alone. However, in some systems I/O may be user-independent, such as when an alert is activated, the input for the alert comes from some other system input, rather than a user.
- **Business rule (process)**: This is a set of rules that govern how a system should function to mimic real-world business processes.
- **Algorithm/application software**: This is the component that integrates all the components. The logic (business rule) is defined in the program

(embedded in it), which enables the functioning of the information system for some specific purpose.

All the above components work in concert to make a functional information system.

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Check Your Progress

1. What is organizational information?
2. What are the methods of assessing information needs?
3. Define MIS.
4. What is a data model?

1.4 INTRODUCTION TO MIS

Meaning of MIS

Management Information System (MIS) is a term used to refer to a class of information systems, that provides the management with the information required for decision-making. The three words which constitute the term, Management Information System, have a role to play in its design and functioning.

Management is the unseen force that drives an organization. It is the lifeblood of an organization. People performing various management roles in an organization are called managers. These managers are the key people within an organization who are responsible for the smooth functioning of the organization. The managers are divided into different levels depending on their level of authority and power. Normally, the higher the level of a manager, the higher the authority he has in an organization. However, authority does not come without checks and balances. With authority comes responsibility. In fact, in management there can be no authority without responsibility. Managers at different levels perform important tasks. However, the most important task they perform is the task of taking decisions.

Information is the key ingredient for taking decisions; that is why management values information. Information improves the quality of decision-making, which is the most important task of management and hence information is the most important asset for managers. Information is created after processing data, mostly transaction-level data. This transaction-level data has to be captured, stored and then processed to create any meaningful information for managers.

A *system* can be defined as a set of interacting entities having interrelation, interconnections with each other, forming an integrated whole. System in the context of MIS in today's times means a process (technology-enabled) for capturing data, storing it and then processing/analysing it to provide information.

Information systems that help a management in taking decisions are called management information systems. MIS consists of a set of information systems working towards the common goal of achieving greater efficiency in decision-making at each level of management. Typically, MIS deals with internally-generated

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information. The in-house data is processed (summarized/aggregated) to create reports, which helps a management at different levels in taking decisions. Today's management information systems have a data repository at the core, which is mostly in the form of a relational database management system. All in-house data (mostly transaction-related) are saved in this database, which is itself designed on the basis of set rules. Over this data repository are several tiers of logic and/or business rules, which help in creating an interface and various reports to be used by managers at different levels. An MIS is normally designed in order to achieve information flow, which is based on the 'need to know' principle. This means that any manager would be given only that type of information to which he is entitled and has any use. This means that a shop floor supervisor may get the details of all personnel working under him, but will not get the salary details of the CEO as he/she is not entitled to know such information or will not get the details of all employees working in the human resource department as he has no use for such an information. This hierarchical rule-based information delivery to the different levels of management is put in place to avoid both information overload and enable security of information.

Many modern systems have come up in recent times to help managers in their tasks like Enterprise Resource Planning system, which is a transaction processing/support system but comes in-built with the best practices of the industry and helps in generating integrated scenarios for managers at different levels. Customer Relationship Management system helps in the management of customers by creating profiles and making available complex analytical tools to managers for processing customer data. Similarly, there are systems to help managers deal with supply chain data called Supply Chain Management system. All these modern systems basically help in achieving greater efficiency by making the job of management decision-making better and therefore, falls under the category of Management Information System.

MIS is a set of systems, which helps the management of an organization at different levels to take better decisions by providing the necessary information.

The role of information technology in developing good MIS is meant to enhance the timeliness and quality characteristics of the information. The subject of MIS does not necessarily mean a study of information technology; however, MIS now has an overwhelming component of IT in it.

MIS is not a monolithic entity but a collection of systems, which provides a user with a monolithic feel. The different subsystems working in the background have different objectives, but work in concert with each other to satisfy the overall requirement of managers for good quality information. MIS can be installed by either procuring 'off-the-shelf' systems or commissioning a completely customized solution. Sometimes, management information systems can be a mix of both[1], i.e., an 'off-the-shelf' system but customized according to the need of the organization.

However, before we proceed any further, we must have a clear understanding of what managers do in an organization and why they need MIS.

Managers are the key people in an organization who ultimately determine the destiny of an organization. They set the agenda and goal of an organization,

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plan for achieving the goal, implement that plan and monitor the situation regularly to ensure that deviations from the plan are controlled. This set of activity ensures the smooth functioning of the organization and helps it attain its objectives and hence these managers are vital for a successful organization. The managers, in turn, conduct these activities, collectively called management functions, by doing something that others in the organization do not i.e., *decide*. They decide on all such issues that have relevance to the goals and objectives of an organization. The decisions range from routine decisions taken regularly, to strategic decisions which are sometimes taken once in the lifetime of an organization. The decisions themselves differ in terms of:

- Complexity
- Information requirement for taking the decision
- Relevance
- Effect on the organization
- Degree of structured behaviour of the decision-making process

Different types of decisions require different types of information. Information systems, which supply relevant information to managers to enable them to take decisions are collectively termed as Management Information Systems. They have common characteristics and even though their actual implementation in an organization may differ according to the needs of an organization, their basic characteristics remain the same. The information technology platform on which MIS is based may also vary in terms of complexity and scale, but the technology component does not change the broad characteristics of the MIS. Technology is the only medium through which a solution is delivered.

Conceptually, MIS and information technology are two very different things. MIS is an information management concept and has no technological component. Indeed, technologies will change and have changed in the past but management information system and its requirement and characteristics will broadly remain the same. Only MIS with changing time and technology regimes will have different technology platforms. In the early 1970s, MIS was mostly run on the mainframe computers with COBOL programs. In the 1980s and 1990s, it changed to a personal computer-based solution using networking, databases and 4GL tools. Today, MIS runs on advanced computer networks with wireless connectivity with hugely advanced software tools, but the broad characteristics of MIS have remained the same. In the 1960s and 1970s also, it was instrumental in providing information, which helped in management decision-making, just like today. Only the degree and quality of information has improved. However, the character of MIS has not changed with the changing technology. Technology has always been and will be a platform for MIS. However, the technology intervention to provide a platform for MIS has increasingly grown over time and some confuse MIS with the technology on which it runs. Technology has become an integral part of MIS but one must appreciate that MIS is a much larger concept critical to management decision-making.

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Information Technology

The term 'information technology' or IT as it is commonly called, refers to the technology that uses computer software and hardware for the purpose of processing data and producing useful information.

The Information Technology Association of America (ITAA) defines information technology as the 'Study, design, development, implementation, support or management of computer-based information systems, particularly software applications and computer hardware for the purpose of converting, storing, protecting, processing, transmitting and securely retrieving information'.

Today, information technology impacts all aspects of our lives and is now an integral part of our everyday activities. It covers a wide range of activities like a simple information storage or retrieval, hardware installation, data management, communication over networks and software development.

Uses of Information Technology

IT can mean different things to different people. IT and its applications are used widely across every section of society, business, education, government, etc. Household devices such as televisions, telephone, radios, microwave oven, dish washers, washing machines and mobile phones, all involve information technology in one form or another. E-mail, word processors, spreadsheet software, the Internet, and communication software have redefined the way people work and are now an integral part of our daily lives.

Some of the common uses of IT are:

- Telecommunications through the use of e-mail, telephonic exchange, remote data transfer, etc.
- Publishing, whether online or through printed material.
- Weather forecasting uses computer systems to process data in order to predict upcoming weather patterns.
- Commerce, whether through the selling of goods over the Internet (e-commerce) or using computers to manage accounts, stock control, etc.
- Industries use IT in many processes, such as Computer-Aided Design (CAD), control of manufacturing systems, Database Management Systems (DBMS), Enterprise Resource Planning (ERP), Management Information System (MIS), and Remote Sensing.
- Banking, in its current form, relies heavily on IT to perform transactions, store huge amounts of financial information, and interact with customers and partners.
- IT-enabled Services like Business Process Outsourcing (BPO) and Knowledge Process Outsourcing (KPO).
- Administration, whether of a business, an educational institution or public entity is enhanced by the use of IT.

1.5 ROLE AND SCOPE OF MIS IN MODERN MANAGEMENT

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Let us first understand the two terms, *information* and *system* individually. Information is that data which has been simplified into a form that is meaningful to human beings (see Figure 1.9). Data represents some raw facts and figures that are derived from some observations, experiment, or events. Data, until organized into a meaningful form, cannot help in the decision-making process.

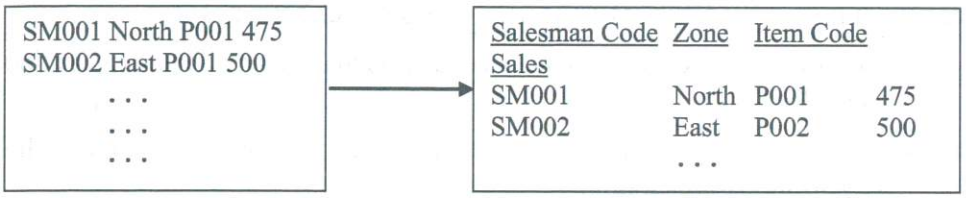

Fig. 1.9 *Data and Information*

The second term, that is, system, may be defined as a set of interrelated components that are put together to achieve a common task or goal. Often, a system is composed of several subsystems, which may further be composed of other subsystems. Subsystems focus on achieving the sub-goals and contribute to the main goal. They can take input from other subsystems (or systems), process it, and produce output.

Information system is thus concerned with processing the raw facts into information and transferring this information to the users. It also takes feedback from the users so that input can be given.

An information system can be manual (that uses pen, pencil, or paper technology) or computer-based. Here, however, the focus is on computer-based information system (CBIS) that uses information technology (IT) to perform its various activities. The term information technology refers to all the components that a system needs to operate, including the following:

- **Software:** Operating system software, database management software, Web browsers, etc.
- **Hardware:** Servers, computers, input/output (I/O) and storage devices.
- **Telecommunication:** Telecommunication channels, telecommunication processors (modems, switches, routers, etc.), software to support the Internet and other private networks (either wireless or wire-based), etc.

Note: The term information technology and information system are often used interchangeably.

The primary aim of corporate information management is information integration which serves as a basic foundation. The scope and role of MIS changes from stand-alone systems such as DSS (decision support system), and EIS (executive information system), to the integrated component of information management.

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To classify MIS, one should first understand its business perspective. There are many different areas of MIS having possibilities and important roles. The second approach for classifying MIS is by system architecture. For this too, different sub-types of MIS and middleware should be identified. Tasks and potentials of middleware and MIS are put forward and real-life examples from companies are discussed.

The main scope of MIS corresponds to different phases such as analysis, design, planning and construction. These also include many other activities such as implementation, utilization, evaluation and handling of information systems for coordinating various activities in the organization. Such activities are:

- Aimed at most effective utilization of organizational resources using information technology
- Handling information technologies in an interactive way in relation to the organizational structure
- Regular evaluation of information systems
- Analysis of the existing model including changes required in design and implementation of computer-based information systems
- Incorporating data, knowledge and information in the organization
- Application of information systems such as transaction processing, routine data processing, decision support and using relevant data/information to support other systems such as expert support system and executive support system
- Activities related to research in the field of cognitive science, knowledge engineering, and systems theory and its application in operations management

The nature of MIS is passive. It only supplies information to managers; it does not actively lead managers to a decision. Managers take decisions without the support of MIS. The systems only supply background information, on which such decisions are based. The systems do not provide active support to the manager's decision. It does not have models to imitate the real-life scenarios as a proactive system as in the case of the decision support system. It only supplies the basic information. Even though this role of providing information is very important, it is only an enabler for better decisions. The scope of MIS is thus limited in a way.

Characteristics of MIS

Management information being a specialized information system category, conforms to certain characteristics. These characteristics are generic in nature. These characteristics remain more or less the same even when the technology around such systems changes:

- **Management-oriented:** One important feature of MIS is that it is designed top down. This means that the system is designed around the need for information of the management at different levels. The focus of the system is to satisfy the information needs of the management.
- **Management-directed:** Since MIS is 'for the management', it is imperative that it also should have a very strong 'by the management'

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initiative. The management is involved in the design process of MIS and also in its continuous review and upgradation to develop a good quality system. The system is structured according to the directions factored in by the management. This helps in minimizing the gap between the expectation of the management from the system and the actual system.

- **Integrated:** MIS is an integrated system. It is integrated with all the operational and functional activities of the management. This is an important characteristic and requirement for a system to qualify as an MIS. The reason for having an integrated system is that information in the managerial context for decision-making may be required from different areas within the organization. If MIS remains a collection of isolated systems, each satisfying a small objective, then the integrated information needs of managers will not be fulfilled. In order to provide a complete picture of a scenario, complete information is needed, which only an integrated system can provide.
- **Common data flows:** Since MIS is required for an integrated system, the data being stored into the system, retrieved from the system, disseminated within the system or processed by the system can be handled in an integrated manner. The integrated approach towards data management will result in avoiding duplication of data, data redundancy and help simplify operations.
- **Strategic planning:** An MIS is never designed overnight. A high degree of planning goes into creating an MIS. The reason for this kind of planning is to ensure that the MIS being established not only satisfies the information need of the managers currently, but also serves the organization in the next five to ten years with modifications. Sometimes, when the planning is over, systems tend to perform well in the present but tend to become obsolete with time. Planning helps to avoid this problem.
- **Bias towards centralization:** Since an MIS is required to give 'one version of the truth' (i.e., it must supply the correct version of the latest information), there is a requirement for the data repository to be centralized. Centralized data management helps an MIS to exercise version control as well as provide an integrated view of data to the managers. In a non-centralized system, data is entered, updated and deleted from different locations. In such a case, it becomes difficult to provide the correct information to managers. For example, in a decentralized system if a person superannuates from an organization and his superannuation is only recorded in the human resource system but not communicated to the finance department system, then it is quite likely that his salary may be generated by the finance system for the next month. A centralized system where data is entered, updated and deleted from only one location does not suffer from such problems. In a centralized system, the superannuating employee's details are deleted from the master file, thereby eliminating the risk of generating his salary for the next month.
- **Information and communication technology-enabled:** The extreme pressure of competition requires information to be timely and accurate for effective decision-making, both of which can be ensured if information is managed using IT. Hence, any modern MIS has a very high dose of

technological intervention in it. In fact, all MIS that run today, run on some ICT platform, to enable smooth functioning of the system and ensure timely and accurate results.

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Functions of MIS

The broad functions of MIS are as follows:

1. **To improve decision-making:** MIS provides background information on a variety of issues and helps improve the decision-making quality of the management. The fast and accurate information supplied by the MIS is leveraged by managers to take quick and better decisions, thereby improving the decision-making quality and adding to the value of company.
2. **To improve efficiency:** MIS helps managers to conduct their tasks with greater ease and better efficiency. This reflects in better productivity.
3. **To provide connectivity:** MIS provides managers with better connectivity with the rest of the organization.

MIS generally has an applicability in system decision-making. For example, MIS can be used to identify problems needing urgent attention for solutions with a timely feedback, to make the upper managers aware of the current progress and its shortcomings. Thus, there are many functions of MIS depending upon the tasks that an organization performs. The main functions of MIS are:

1. **Data processing:** This comprises collection, transmission, storage and processing of data to provide an output.
2. **Prediction:** It carries out analysis on data to predict a future situation, by applying methods of modern mathematics, statistics or by way of simulation.
3. **Planning:** The analysis of data of a regular nature may give many indications on likely future events or situations and this can be utilized in planning or reviewing the plan already made earlier.
4. **Control:** From a record of day-to-day activities, monthly activities, quarterly or annual activities, certain factors may be noted that need control. These factors may be controlled without much difficulty, if noted on time. There may be certain factors that need the attention of the higher management to remain under control. But there are many small factors that if ignored in the beginning, may disturb other factors as well.
5. **Assistance:** Providing assistance to the higher management by analysing and inferring from regular records about various factors related to the performance of the business operation, is one of the main functions that MIS has to provide. This data may pertain to human resources, financial resources, material resources, etc.

1.5.1 Organizations and Information Systems

Different organizations may have different needs. Information systems are developed to serve the needs of a particular organization. The role and use of information

system is influenced by the needs of organizations, surrounding environment, etc. At the same time, organizations are influenced by the information systems. Introduction of a new information system affects the organization's structure, day-to-day working, performance, productivity, work design, etc.

What is an organization?

An organization can be defined in more than one way. From a technical viewpoint, an organization is a formal social structure that takes inputs from its surrounding environment and transforms these inputs into outputs through production process. Here, inputs consist of capital and labour provided by the environment, and outputs are products and services. The environment consumes the outputs (products and services) and provides more inputs (capital and labour) in the feedback loop (see Figure 1.10).

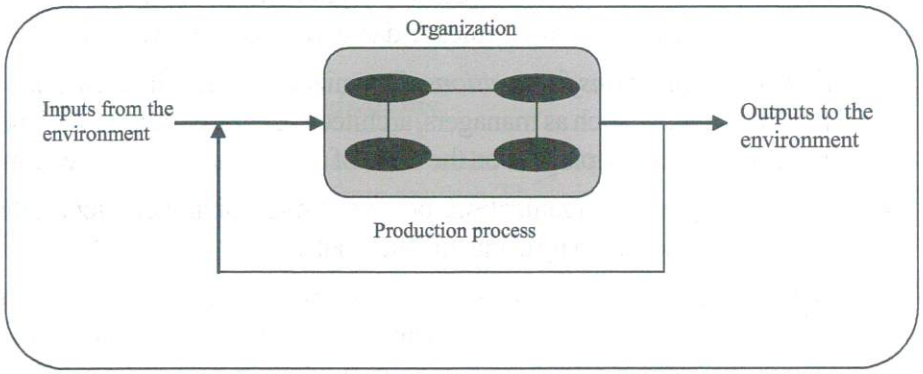

Fig. 1.10 *Technical View of Organization*

Another more descriptive definition of an organization is from the behavioural point of view. From this view, an organization is a collection of rights, privileges and responsibilities that are balanced over a period of time. Figure 1.11 illustrates the behavioural view of an organization.

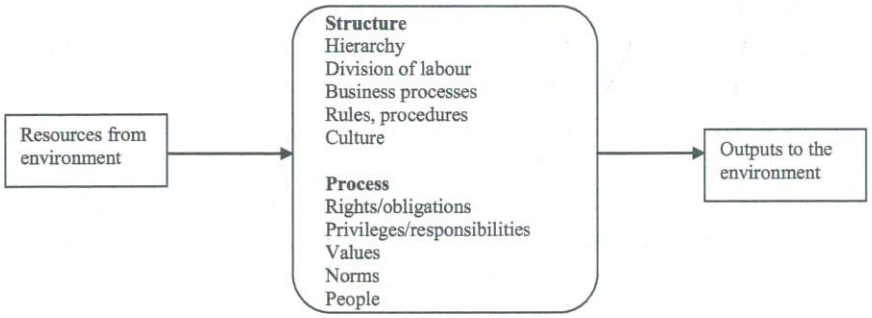

Fig. 1.11 *Behavioural View of Organization*

Common and unique features of organizations

Almost all organizations have some features that are common to them. Other features of organizations distinguish one organization from another.

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Common features of organizations

Some of the features common to all organizations are as follows:

- *Hierarchy:* Organizations are hierarchical structures with different levels and specialists. All specialists are arranged in a hierarchy of authority and responsibility. The hierarchy arranges people in a pyramid of rising authority and responsibility. Managers, professionals and technical employees are at the upper levels, while the operational personnel are at the lower levels.
- *Rules and procedures:* Authorities and responsibilities are defined by rules. Organizations develop different rules to accomplish tasks. These rules guide the employees in various procedures such as writing bills, replying to customer complaints, and so on.
- *Unbiased judgements:* Rules created by organizations are impartial; that is, everyone must follow those rules and everyone is treated equally.
- *Technical qualifications for positions:* Organizations need different people with different skills, such as managers, architects, engineers and so on. They recruit and train the employees on the basis of their technical qualifications.
- *Maximum efficiency:* Organizations believe in maximizing efficiency, that is, maximizing the output by using limited inputs.
- *Organizational culture:* All organizations have some basic, secure, and undisputed assumptions that define their goals and products. Organizational culture is this set of assumptions that describes the products to be produced by the organization, how to produce them, and where and for whom to produce. It is a powerful force that limits political differences and encourages common understanding, agreement on procedures and common practices. It adds significantly to the organization's goodwill and reputation, thus leading to on-time projects and high productivity.
- *Routines and business processes:* Individuals in all organizations develop some routines over time for producing goods and services so that the organizations become more efficient. These routines (also called standard operating procedures) are specific rules, methods and practices developed to deal with all the expected situations. These routines help employees to become more creative and efficient. In a school, for example, a receptionist has some specific set of routines for gathering information, teachers have a different set of routines for teaching students, and the principal has a well-developed set of routines for running the school.

Business processes are the collection of such routines. Analysing business processes and routines helps in understanding the actual working of a business. It also helps in making business more effective and efficient. All business processes together make a business firm (see Figure 1.12).

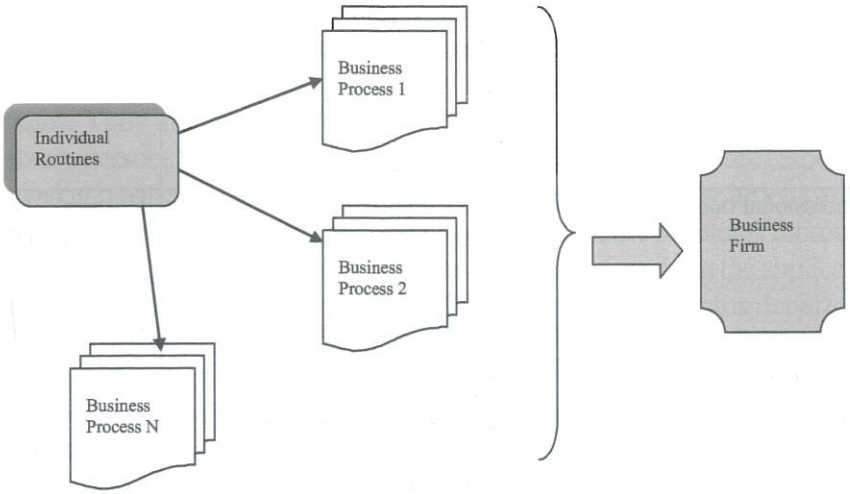

Fig. 1.12 *Routines, Business Processes and Business Firm*

Unique features of organizations

All organizations have some features that are unique to them. These features distinguish one organization from another. These include leadership styles, goals, tasks, structures, and surrounding environments.

The leadership styles differ greatly from one organization to another. Some organizations are more influential or self-governing than others. Another difference between organizations is the tasks performed and the technology used by them. Some organizations perform the tasks that require little judgement (such as manufacturing firms), while others perform those tasks that require judgement in some way or the other (such as educational and consultancy firms). Organizations also differ in their ultimate goals and the power used to achieve these goals. Some organizations have coercive goals (such as prisons), some have utilitarian goals (such as businesses) and some have normative goals (such as universities and religious groups).

The most important factors that make one organization different from another are the organizational structure and its surrounding environment.

- *Organizational structure*

There are several ways of classifying organizations based on their structures. The most common classification is the classification made by Henry Mintzberg, which identifies five basic types of organizations as shown in Table 1.1.

Table 1.1 *Types of Organizational Structures*

Type	Description	Example
Entrepreneurial	▪ Small firm managed by an entrepreneur. ▪ Simple structure. ▪ Solves simple tasks. ▪ Lacks standardization of tasks.	Small new business
Machine bureaucracy	▪ Large bureaucracy. ▪ Produces standard products. ▪ Dominated by centralized management team.	Medium-sized manufacturing firm

Divisionalized bureaucracy	▪ Combination of multiple machine bureaucracies. ▪ Each bureaucracy produces different product or service. ▪ All divisions are handled by the central headquarters.	Firms like General Motors
Professional bureaucracy	▪ Knowledge-based organization where goods and services are dependent on the knowledge of the professionals. ▪ Ruled by department heads. ▪ Weak centralized authority.	Hospitals, law firms, schools
Adhocracy	▪ Task force organization that must adapt to quickly changing environments. ▪ Consists of large groups of specialists that are organized into short-lived multidisciplinary teams and have weak central managements.	Consulting firms

- *Organizations and environment*

All organizations are situated in an environment which could be business, governmental, or educational. In this environment, there are other organizations and people, such as suppliers, clients or customers and competitors with whom transactions have to take place. Organizations, on one hand depend on social and physical environment, financial and human resources. The legislative and other requirements imposed by the government as well as the actions of customers and competitors must be taken into account by the organization. On the other hand, organizations can control their environments. Business firms, for example, bond with other businesses to influence the political process; they advertise to influence customer acceptance of their products.

Information systems play an important role in environmental scanning and also help managers to identify the external changes that require organizational response.

Changing role of information systems in organizations

Information system has become vital for organizations as it helps them to deal with fast-paced changes in global economies and businesses. It provides communication and logical tools and is involved in minute-to-minute operations, thus creating an economic value for the firm. Information systems have changed the economic condition of organizations and enhanced their working conditions. As the technology changes, an organization's infrastructure and the services it provides to its employees, customers, and suppliers also change.

Usually, there is an information systems department in organizations that provide IT services. Typically, the members of information system departments maintain hardware, software, networks, and other components of IT infrastructure.

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Earlier, the department mainly consisted of skilled programmers, whereas nowadays, the department consists of programmers, system analysts and managers. Programmers are the technical persons and are experts in one or more programming languages. They are responsible for developing computer programs. System analysts are persons with good analytical and technical skills. They are responsible for analysing business problems and requirements, and proposing solutions to these problems. They interact with the end-users to understand the problems thoroughly and also discuss with the managers. End-users are people for whom the applications are developed. Though they are not part of the information systems department, they play a major role in designing and developing applications. System managers manage such teams and also the teams of staff responsible for data entry. Many companies now appoint a Chief Information Officer (CIO) as a senior manager who supervises the information system department.

1.5.2 How Information Systems Affect Organizations

Over the last few years, the information systems have greatly changed the organizational economics and increased the possibility of organizing work.

1. Economic impact

Both the cost of information and capital are affected by the change in IT. With the decrease in cost of IT, the dependence of many firms on IT has increased. Further, since the cost of labour and capital has been rising constantly, today's managers have increased their investments in IT. Slowly, IT has started substituting labour and various forms of capital like property and machinery.

Information systems help organizations in running their business effectively with reduced costs. This can be explained with the help of an example. Suppose a company develops a policy regarding the revision of salary. It first instructs the HR assistant to write the plan of policy on paper and forward it to the HR director for review. After the HR director has reviewed (or made certain changes to) the policy plan, the assistant reprints the document. However, if there is an information system, the assistant can directly forward the plan to the director electronically. Further, the director can modify the electronic version of the file and return it to the assistant. Once the plan is finalized, it can be sent to each employee via e-mail, thereby reducing the need to print various copies. Hence, both time and resources are reduced with the use of information system.

An information system also affects the cost and quality of information. It makes the firm smaller in size as it can reduce transaction costs. Transaction costs are the costs incurred when a firm buys the goods which it cannot make itself. The Transaction Cost Theory is based on the notion that firms try to economize their transaction costs in the same way as they economize their production costs. Traditionally, firms have tried to reduce their transaction costs incurred by communicating with remote suppliers, purchasing insurance, acquiring information on products, etc.

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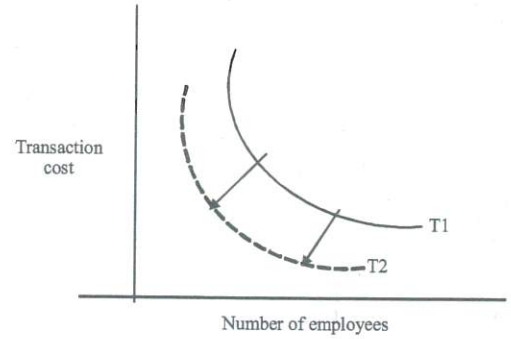

Fig. 1.13 Transaction Cost Theory

Figure 1.13 shows that as transaction cost decreases, the number of employees in a firm (firm size) also decreases. This makes shrinking of the firms easier and cheaper, and they can buy the goods and services from the marketplace rather than make the goods or offer the service themselves. Hence, an information system reduces the cost for a given firm size, thereby shifting the transaction cost curve inward and increasing the revenues of the company.

With the help of an information system, the internal management costs are also reduced. According to the Agency Theory, an owner hires agents (employees) who work on his or her behalf. These agents are delegated some decision-making authority. They are required to be constantly supervised or else they would practise their own interests. The cost incurred in supervising the agents is called agency cost or coordination cost. An information system reduces these agency costs by reducing the cost of acquiring information.

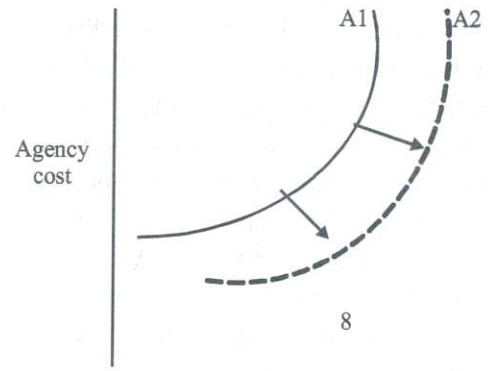

Fig. 1.14 Agency Theory

In Figure 1.14, the agency costs increase as the number of employees (firm size) increases. The information system shifts the agency cost curve down and to the right, thus allowing the firms to increase size by lowering agency costs.

2. Organizational and behavioural impact

The growth of information system and the implementation of new applications have been affecting the structure of the organizations. In this section, we will discuss how and why information system affects organizations.

Information system flattens organizations

Before computerization, the work process in organizations used to remain unchanged for a long time. There were various levels of management that managed the lower

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level staff (see Figure 1.15). Managers were responsible for making decisions and the lower level staff used to operate under the supervision of the senior managers. Since there is a limit on the number of people a person can supervise, the managers failed to efficiently handle large number of employees at the lower level. Therefore, traditional organizations were usually less competitive than the modern organizations that involve advanced IT applications in their work process.

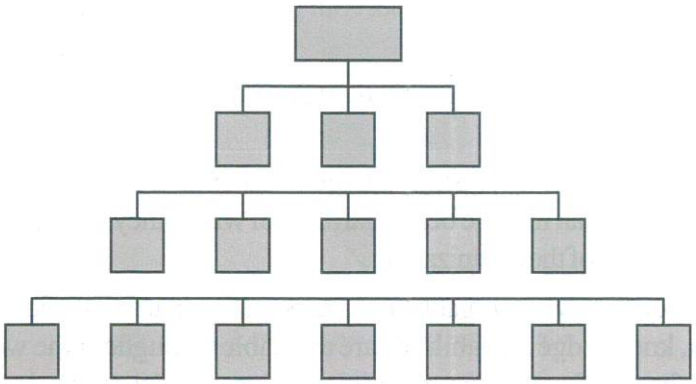

Fig. 1.15 *A Traditional Organizational Hierarchy of Management*

The use of information system has increased the efficiency of today's organizations and it helps flattening the hierarchies. IT applications provide the lower level employees with the information they require and they are empowered to make decisions without supervision. Moreover, the efficiency of managers in making decisions has enhanced because they receive accurate information on time. Therefore, fewer managers are required to supervise more employees than before (see Figure 1.16).

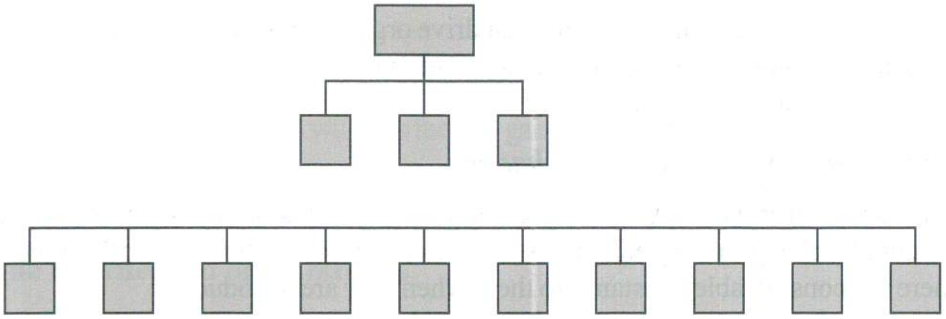

Fig. 1.16 *A Flattened Organizational Hierarchy*

Virtual organizations

IT enables some organizations to act as virtual organizations where work is no longer limited by geographic locations. Virtual organizations connect people, assets, and ideas with the help of networks. They can support customers, suppliers and even competitors in creating and distributing new products and services without any limitation of physical locations. In other words, a virtual organization is one whose members are geographically apart, while appearing to others to be a single, unified organization with a real physical location. Many people are forming virtual companies as the optimal way to implement key business strategies and alliances that ensure success in today's competitive business environment.

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Virtual companies develop flexible and adaptable virtual workgroups and alliances to make best use of fast-changing business opportunities. A business, for example, wants to make use of new market opportunities but it lacks time and resources, and information technologies needed to develop the infrastructure. This problem can be solved by simply creating a virtual company through a strategic alliance so that it can integrate the components needed, such as the Internet, intranets and other Internet technologies, to sort out the customers' problems as well as exploit the market opportunity.

There are many reasons as to why many organizations are implementing virtual organizations:

- *To increase flexibility:* Since a large number of workers is available, the organization can hire the best regardless of where they live, thus increasing the flexibility of the organization.
- *Globalization:* Many organizations now realize that a vast pool of untapped skills, knowledge and abilities are available throughout the world. Thus, when these different skills and abilities are integrated in a virtual organization, greater level of collaboration, cooperation and efficiency is achieved.
- *Changes in employee values and attitude towards work:* Employers have realized that balance of professional as well as personal life, family requirements, and personal fulfilment are important considerations in life.
- *Cost reduction:* The cost of physical assets used to support work environments, cost of infrastructure or the cost involved in maintaining the offices at several physical locations is reduced.

Although there are many situations that drive organizations to implement virtual organizations, not all companies can make virtual work effective because it is difficult to evaluate and organize the workers.

Organizational resistance to change

The use of information systems result in many changes in organizations. They potentially change an organization's structure, culture, politics and work. Hence, there is a considerable resistance to them when they are introduced.

Since organizational resistance to change is very powerful, many IT investments stagger and do not increase productivity. After thorough research on project implementation failures, it is observed that the most common reason why large projects fail to reach their goals is not due to failure of technology, but organizational and political resistance to change. Figure 1.17 depicts that to implement change, all the four components, that is, task, technology, people, and structure must be changed simultaneously.

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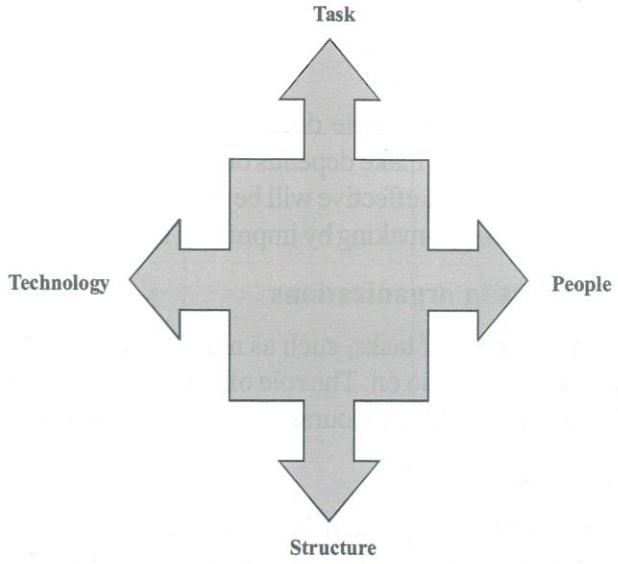

Fig. 1.17 Components of an Organization

Organizational changes may be essential in order to survive competition. Hence, organizations must adapt to fit changing economic factors and other circumstances. Top managers of the organization must try to diagnose the cause of resistance and then work to solve it before it ruins the progress of the organization.

In order to overcome the resistance to change, the following three steps are required.

1. *Generate a climate for change:* A suitable climate should be created by exposing employees to seminars and conferences so that they can focus on the shortcomings of the present system as well as find methods to overcome those shortcomings.
2. *Create effective agents of change:* Organizations should recognize their efficient leaders who could be sent to seminars so that new ideas stimulate in their minds, which will help them in gaining the support of other employees.
3. *Rearrange the organization:* To achieve better working relationships, organizations should be modified to fit evolving organizational behaviour.

The Internet and organizations

The Internet has made phenomenal changes in the working of organizations. It provides precise, timely, and accurate information and also helps in effective decision-making. It increases the accessibility, storage, and distribution of information and knowledge for organizations, thereby lowering the transaction and agency costs. Various banks, for example, in foreign countries can now deliver their procedure manuals for the internal operations' to their employees at remote locations by simply posting them on the corporate website. As a result, the huge amount of money they would have otherwise spent in distribution is saved.

Other than affecting the cost of running an organization, the Internet has also affected the task, technology, structure, culture, and people of the organizations. The tasks, for example, have become automated with the help of technology. Similarly, workers have been transformed to knowledge workers.

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1.5.3 Managers, Decision-Making and Information Systems

The major roles of managers include decision-making for which they rely on information. The decision they make depends on the quality of information. Better the quality of information, more effective will be the decisions. Information systems contribute to effective decision-making by improving the quality of information.

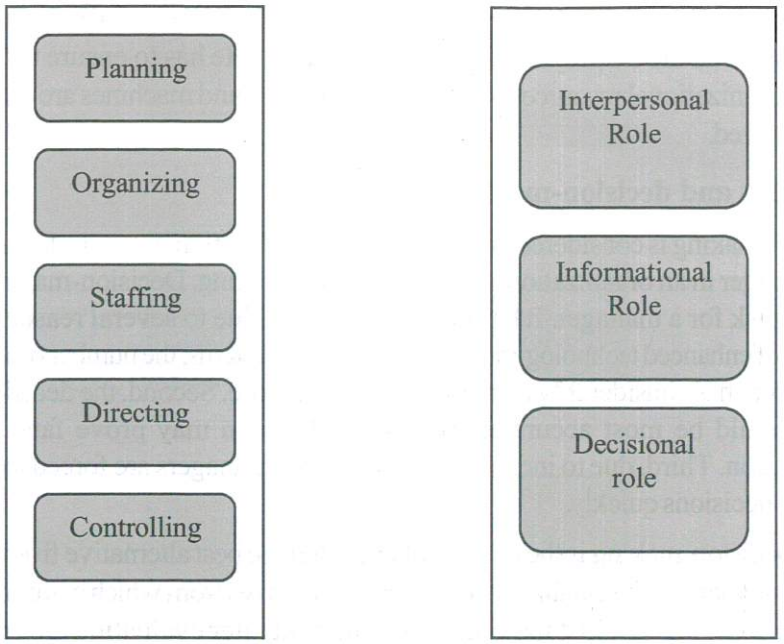
The role of managers in organizations

Managers perform a variety of tasks, such as making decisions, participating in meetings, writing reports, and so on. The role of managers can be better explained by examining the classical and behavioural models of management.

The Classical Model

The Classical Model of Management basically describes what managers do. According to Henri Fayol, the following are the classical functions of managers [see Figure 1.18(a)].

- ***Planning:*** This is a process of predicting the future. It answers questions, such as what to do, when, where, how, and why it should be done. To achieve the plan, managers set goals and lay down policies, procedures, schedules and budgets.
- ***Organizing:*** The process of organizing involves recognizing the job, dividing the job into suitable tasks, assigning the divided jobs to appropriate persons, and delegating authority to get things done by subordinates.
- ***Staffing:*** It is the process of allocating the right job to the right person. It includes selecting appropriate persons for the required positions and training them to carry out their tasks in an efficient manner.
- ***Directing:*** This includes activities such as communication, motivation and leadership. A manager has to guide, motivate and lead his subordinates.
- ***Controlling:*** The process of controlling includes the following tasks:
  - Fixing standards to measure work performance
  - Measuring actual performance
  - Comparing the actual results with standard results and finding out variations, if any
  - Taking appropriate actions



(a) Classical Model *(b) Behavioural Model*

Fig. 1.18 *Role of a Manager in an Organization*

The Behavioural Model

The Classical Model presents formal managerial functions but fails to describe what managers actually do. It does not discuss the tasks that managers perform while planning, decision-making, and controlling the work of others. According to the Behavioural Model, the actual behaviour of managers is less systematic and more informal.

On the basis of manager's day-to-day behaviour, Henry Mintzberg categorized the roles of managers into three categories, namely *interpersonal, informational* and *decisional* [See Figure 1.18(b)].

1. ***Interpersonal role:*** Managers' interpersonal roles can be classified into following three categories. They act as:
   (i) Figurehead: Managers represent their companies to the outside world and perform duties such as presenting awards to employees.
   (ii) Leader: As a leader, managers motivate, guide and support their subordinates.
   (iii) Liaison: A manager acts as a link between the members of the management team.
2. ***Informational role:*** In the informational role, managers need specific and up-to-date information to redistribute it to those who should be aware of it. Thus, managers act as information propagators and spokespersons for their organizations.
3. ***Decisional role:*** In the decisional role, managers have to make routine decisions related to daily operations of the business, such as payment of wages, payment of raw materials, sanctioning leave to subordinates, and so

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on. A manager also acts as a negotiator and resolves conflicts that arise between the employees over certain matters. He has to ensure that all the organizational resources, such as men, material and machines are efficiently utilized.

Managers and decision-making

Decision-making is considered as a core managerial function. Every task performed by a manager in an organization involves decision-making. Decision-making is not an easy task for a manager. It has become complex due to several reasons. First, because of enhanced technology and communication systems, the number of available alternatives has considerably increased than ever before. Second, the decision to be taken should be most accurate; any wrong decision may prove fatal for the organization. Third, due to increasing competition, managers are forced to act fast and take decisions quickly.

Decision-making is the process of choosing the best alternative from among various alternatives. It visualizes two or more alternatives from which a final decision is to be made. It is not just making a commitment after evaluating alternatives; rather it is a complex issue. It includes the whole process of setting up of goals, defining activities, finding alternatives, and developing plans. It involves all the activities of coordinating, information processing, problem solving, and evaluating, before finally making a decision.

Decision-making process

Decision-making is a process that consists of various different activities. According to Herbert A. Simon, a decision-making process can be described in four different stages, namely *intelligence*, *design*, *choice* and *implementation*.

(i) *Intelligence:* This stage includes finding, analysing and understanding the problem, the nature of the problem, the reason for its occurrence, and its effects on the organization. In this stage, information system provides detailed information in the form of routine reports, interpreted transaction data, and exception reports that help in identifying the problem.

(ii) *Design:* This stage includes finding the possible solutions for the problem. Here, the Decision Support System (DSS) proves to be of great help as it provides the user with logical tools for modelling data, thereby enabling users to find possible solutions for the problem.

(iii) *Choice:* This stage includes choosing the optimal solution among the alternatives. The Group Decision Support System (GDSS) provides an electronic environment to conduct group discussions among all managers, who discuss the various alternatives and select the suitable solution for the problem.

(iv) *Implementation:* This stage includes putting the solution to work and monitoring the working of the solution. It also includes analysing the chosen solution and finding whether the applied solution is the optimal solution by comparing it with other possible solutions. Here, MIS provides routine reports and informative data that help in analysing the solution.

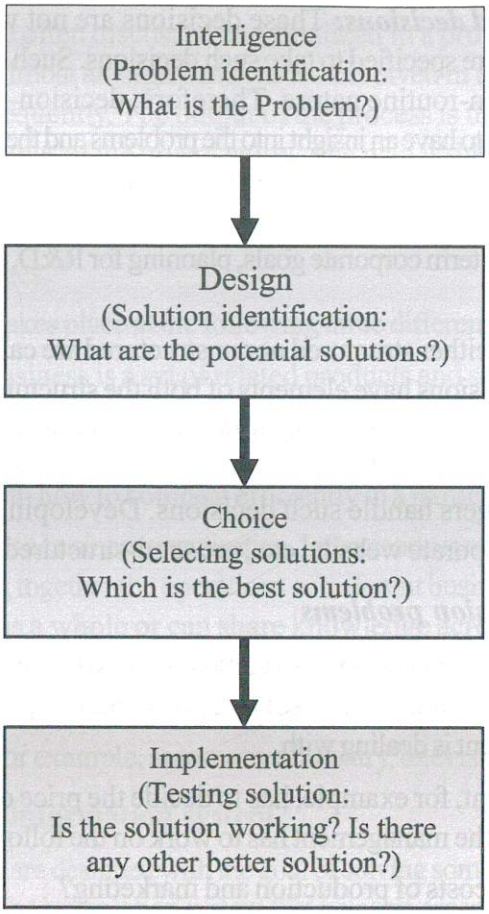

Fig. 1.19 Stages in Decision-Making

According to Simon, the four stages in the decision-making process are linear in nature and occur in an orderly manner one after the other (see Figure 1.19). But in reality, the stages in decision-making do not necessarily follow a linear path. A manager, for example, may be in the process of implementing a decision only to discover that the solution may not be the optimal one. In such cases, the manager is required to repeat the previous stages.

Types of decisions

There are several decisions taken by managers in an organization. These decisions differ in a number of ways. One classification can be on the basis of level of programmability—Simon proposed two types of decisions, namely *programmed* and *non-programmed* decisions. G. A. Gorry and M.S. Scott Morton referred to these programmed and non-programmed decisions as structured and unstructured decisions respectively.

(i) ***Structured decisions:*** These decisions are well defined, certain, and need little effort from decision-makers. These decisions need to be made at a small interval of time. They can be easily made using some definite procedure; thus, operational (lower) level managers are permitted to take such decisions. Inventory reorder decisions, routine credit decisions, etc., are structured decisions.

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(ii) ***Unstructured decisions:*** These decisions are not well defined and no certain rules are specified to take such decisions. Such decisions are critical and are of non-routine nature. Therefore, decision-makers must spend sufficient time to have an insight into the problems and then use their judgement and intuitions to finalize a decision. Such decisions are taken by strategic (higher) level managers of the organization. Introduction of a new product, deciding long-term corporate goals, planning for R&D, etc., are unstructured decisions.

Decisions that are neither structured nor unstructured are called semi-structured decisions. Such decisions have elements of both the structured and unstructured decisions, and thus, there are some well-defined or certain rules for some part of the problem; the rest needs to be solved using judgement and intuition. Generally, middle level managers handle such decisions. Developing a marketing plan, designing a new corporate website, etc., are semi-structured decisions.

Management decision problems

A situation where the management of a company has to take a decision that requires research is called a management decision problem. It is just a statement of the issue that management is dealing with.

A management, for example, has to decide the price of a new product. To solve this problem, the management has to work on the following issues.

- What are the costs of production and marketing?
- What will be the product's status in the market?
- At what price do similar types of products sell for?
- What is the perceived value of this product in the market?

Implications for the design and understanding the information system

The developer of information systems must have complete knowledge about the organization for which they are developing an information system. The design process of an information system is complete and efficient when it fulfils the requirements it was meant to achieve. While planning a new information system, the following factors must be considered.

- Organizational structure
- Organization's type and leadership style
- Surrounding environment of the organization
- Organization's culture
- Nature and attitude of end-users of the system

1.5.4 Information Systems and Business Strategy

Business strategy is long-term planning of organizations that determines what products (or services) they provide, the market they compete in, their customers and suppliers, their future plans, etc.

Strategies are often discussed and finalized in a process called strategic planning process. Almost all organizations are involved in this process yearly or sometimes more frequently. The output of the process is the strategic plan that depicts all the strategies of the organization. The plan is then handed over to the managers of the organization to achieve the planned goals. Note that changes in the surrounding environment affect the organization's goals, and the plan must adapt to these changes.

Generally, strategy takes place at the following three different levels.

(i) **Business:** Business is a set of related products and services. Information systems assist firms in becoming low-cost developers, distinguishing products and services and serving new markets. The strategy at this level is mainly concerned with how to compete efficiently in a particular market.

(ii) **Firm:** A firm is a business organization. Information systems enhance services by combining together the operations of different business units so that they can operate as a whole or can share knowledge across various business units.

(iii) **Industry:** Several firms that constitute an industrial environment is called an industry; for example, automotive industry, television broadcasting, etc.

What is strategic information system?

Information systems are designed with the goal of solving some problems or seeking new opportunities. The information system that helps an organization to accomplish a long-term competitive advantage is known as Strategic Information System (SIS). It can be developed from scratch or by modifying an existing system.

These systems change the goals, operations, products, services, and processes of the organization to help it gain an edge over the competitors. Sometimes, even the organization's business needs to be changed, which in turn forces it to adopt the new behaviour patterns. All these result in changing internal operations, recruiting new managers and workforce, and establishing close relationships with customers and suppliers.

Business-level strategy: The Value Chain Model

The most commonly used model to support business-level strategies is the Value Chain Model. According to this model, every firm is a sequence of basic activities, with each activity adding some value to its products or services. The model aims to identify those activities where information technology can be applied effectively to help a firm in gaining advantage over its competitors.

The basic activities that constitute a firm are classified into primary and support activities. Primary activities are directly associated with production and distribution of products or services of a firm that create value for the customer, whereas support activities provide support to primary activities. Various primary and support activities along with the type of strategic information system that can be used to make them cost-effective are listed in Table 1.2.

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Table 1.2 Primary and Support Activities and the Type of Information System Used

Activities		Description	Type of SIS Used
Primary	Inbound logistics	Includes receiving and storing materials for distribution	Automated warehousing systems
	Operations	Converts inputs into finished products	Computer-controlled machining systems
	Outbound logistics	Involves storing and distributing finished products	Automated shipments scheduling systems
	Sales and marketing	Includes promoting and selling products	Computerized ordering systems
	Service	Includes maintaining and repairing goods or services	Equipment maintenance systems
Support	Organization infrastructure	Administration, management	Electronic scheduling systems
	Human resource	Hiring and training of employees	Workforce planning systems
	Technology	Improving products and production process	Computer-aided design systems
	Procurement	Purchasing inputs	Computerized ordering systems

Internet technologies enable firms to expand their value chain to include customers, suppliers, and other business partners, thereby creating a *value web*. A value web is a group of independent firms that coordinate their value chain with the use of information technology to generate a product or service for a market collectively. Using the value web, the firms can maintain long-term relationships with their customers, as well as adjust to the changing demand and supply needs.

Firm-level strategy and information systems

The overall performance of a firm depends on the performance of each business unit. The performance can be improved if all the business units work together instead of on their own and share knowledge. The information systems promote synergy by integrating separate business units so that they can act as a whole. The business units are combined in such a way that the outputs of one unit become inputs to other units, thereby lowering the cost and increasing the profits.

Information systems encourage sharing of knowledge, and thus, help in creating a core of competency. A *core competency* is an activity for which a firm is the foremost leader. It may include the world's best toymaker or the best package delivery service. It depends on the knowledge that is obtained over several years of experience and a good research organization. Such a system also improves existing competencies and enables the employees to become aware of the new external knowledge.

1.6 FUNDAMENTAL CONCEPTS OF MIS

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Information remains 'valuable' only when supplied 'timely' and 'accurately' to a management. This insatiable need for information in a business organization has given rise to the discipline of management information system, which deals with the methodical study of a seemingly disparate set of subjects that includes management systems, information systems, information theory and information technology. It deals with the purpose, planning, construction, implementation and operation of a set of systems (information gathering, assimilating and disseminating systems). Theoretically, it can be manual, but the compulsions of a modern competitive environment dictate that MIS be in a computerized environment.

Several types of MIS exist, ranging from the very basic in which the everyday tasks in an office are automated to the very complicated in which the system uses artificial intelligence and other advanced techniques to help the managers in decision-making. However, in all such systems the purpose of MIS is to assist the management of an organization in performing their tasks and aid in decision-making. MIS in most cases supplies information on a 'need to know' basis to the management; the type of information it supplies to the different levels of management differs in type and content.

The focus of an MIS is to supply the right information to the right person at the right time. This triad of the right person, the right information and the right time makes MIS a powerful tool essential for business organizations. If any of the three entities—person, information and time—is not right, then the MIS fails in its objective. Hence, the purpose of the MIS is to maintain the flow of information within an organization by focusing on the triad of right person, right information (i.e., the accuracy of the content of information) and right time. The entire study of MIS focusses on these three things and aims to improve upon them.

Trends in modern business show that the business environment has progressively become complex. Competition is now at a cut-throat level and there is hardly any scope for error. Managers have to be on their toes all the time, analysing the business environment and taking decisions to solve problems in order to take advantage of an opportunity. Thus, the focus is very much on decision-making. However, decision-making itself is of several styles. It can be intuition-based or data-based. The modern environment favours the data-driven informed approach of decision-making. Thus, in order to take a decision, the manager has to have some background information about the issue. This competitive environment and the associated role of the manager has given rise to a discipline called information management, which deals with gathering, storing, analysing, retrieving and disseminating information within an organization. In today's environment, information management is essential for a modern manager to take any worthwhile decisions.

1.6.1 Management

Managers take decisions based on several triggers. Some managers are optimists and take an optimistic view of any situation, be it a problem or an opportunity,

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while others take a completely pessimistic view. They look at only the negative aspects of decisions. Some managers take decisions based on intuition, i.e., the reaction they feel coming from within themselves, their instinct. Some take decisions based on the analysis of data. These data-driven managers rely wholly on information systems to provide them with the necessary data and information in the form of reports. Nowadays, the prevailing view is that data and analysis-driven decisions deliver greater value to the organization than intuition-based decisions. In the instinct-based decision-making approach, the judgement and experience of the manager plays the most important role in choosing an alternative. However, even an experienced manager can be wrong when deciding on the basis of instinct. Hence, conventional wisdom suggests that managerial decisions must be taken on the basis of solid rationale and information. If the manager has complete information about a problem or opportunity, then he can take an appropriate decision; else, his decision will be based on intuition or judgement, which is prone to personal bias and hence is likely to be inaccurate. Therefore, managers in today's world are increasingly data-driven rather than feeling-driven.

Before understanding the role played by the management in an organization, we must appreciate that the management is the invisible force that runs an organization. Managers get things done efficiently and effectively (mostly by others), thereby adding value to the organization. They plan, organize, direct and control the employees in order to ensure that everyone in the organization works towards a common goal. An organization without managers would have no cohesion, no purpose and no direction. It will simply collapse. Managers perform multiple roles within an organization. The role of the management can be divided into three categories—interpersonal, informational and decisional. The role of the management under different categories is as follows:

- **As a titular figurehead whose role is only symbolic:** The person who performs this role is widely respected within the organization and known for some special quality or contribution to the organization and society. Even though the person is a figurehead and does not enjoy a lot of actual authority and power, he/she helps to galvanize the employees to work towards a greater goal. This kind of role is often very important for the success of an organization.
- **As a leader who takes responsibility of getting things done by inspiring and motivating his people:** In this role, a manager works like an inspirational guru to the people in his domain of influence. This role is sometimes performed by the management at junior level also, when managers lead by example, rather than on the basis of power and authority vested upon them. Several managers who have worked in shop floors have been known to inspire workmen and get things done by inspiring and motivating people.
- **As a liaison agent who interacts with social networks for business development and other related activities:** In this role, the manager works like a salesperson and a representative of the company, interacting and networking with people to get more business and achieve other related goals.

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- **As a control monitor who controls the organizational activities:** In this role, the manager is a control master, who keeps a close tab on the activities within the organization and corrects any deviations from the planned result. A manager plays this role when he is in a middle-level position. He exercises his power to control the organizational system and regularly acts on feedbacks.
- **As an information disseminator who relays information from top down and bottom up:** A manager needs to be a good communicator to be able to achieve this. In this case, the role of the manager is not only to act as a post office, but also to ensure that the disseminated information is understood by all concerned.
- **As a communicator/spokesperson who communicates with the environment:** In this role, the manager works like a public relations specialist for the organization and communicates the key issues facing the organization to the market, buyers, sellers, regulators, etc.
- **As an entrepreneur who hunts for opportunities and initiates changes:** In this role, the manager brings a particular opportunity to the fore and initiates steps to benefit from it.
- **As a troubleshooter who solves organizational problems and does mid-course corrections:** In this role, the manager works as a control agent who ensures that corrective actions are taken at the appropriate time to thwart any problem.
- **As an allocator of resource:** In this role, the manager decides on the quantum of resources required for completing activities under his domain.
- **As a negotiator who manages deals for the organization:** In this role, the manager works as the sole representative of the organization keeping in mind the best interests of the organization.

All managers perform all these roles in their regular course of work but some managers are more adept in performing certain roles, which they do with great élan.

Why is MIS required by a manager?

A modern manager is responsible for the most important task within an organization, i.e., taking decisions. However, if we are to categorize his tasks on the basis of staffing, planning, controlling, organizing and leading, we would have to say that different managers at different levels spend different amounts of time and effort in each of these categories of activities, even though most managers would be required to perform all the activities in their own domain of influence. For performing his tasks in each of the above-mentioned activities, the manager needs information. Without information he cannot perform his role in any of the activities of planning, organizing, directing or controlling. For example, a manager when performing the task of planning would need to know many things. Some of the issues that he needs to be aware of are as follows:

- What is the objective of the plan?
- What are the parameters that need special attention while planning?

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- What are the independent variables and what are the dependencies?
- What are the things one must take into consideration to ensure that the plan is realistic?
- What is the context under which the planning is done?
- What are the key issues related to the plan?
- Who are the key people involved and affected by the plan?

Answers to all these questions will be required if the manager has to establish a suitable plan. However, each question has several questions/issues embedded in it. As we can see, a vast amount of information is required to set the process of planning into motion. A manager in today's modern competitive business environment may not be fully aware of all the issues and the information against each issue. This is precisely the reason why he needs to rely on a system that provides him with this necessary information. MIS bridges this gap by providing the manager all the necessary information from different angles, thereby making the task of the manager easier. The same is the case when the manager is organizing, directing or controlling. In each sphere of activity, the manager needs information just as he needs it in the case of planning. Normally, the means to get the information is through reports. Reports are formatted documents, which arrange information in such a manner that the manager understands the meaning of the information being provided in the document easily, without any further analysis. Visualization of data and information is a common tool used to make the report easily comprehensible and also to provide managers with an insight on a particular issue. Visualization can be done in several ways. The easiest way to attain visualization is to use graphs in reports. A pictorial representation of data in the form of a graph conveys greater meaning to the manager than data being presented in a plain text. Hence, reports have a bias towards graphical representations. Moreover, the preformatted nature of the report, called report structure, helps the manager to quickly access the information he requires. He knows what information is available in which part of the report and can save time by accessing the particular portion of the report he needs. This is another feature of reports.

Management reports

The means by which a data-driven manager achieves his tasks is through the use of reports. Reports convey to the manager the following:

- They give him an idea whether the activities under his sphere of influence are proceeding according to his expectations. For example, when a production manager checks the production schedule and compares it with actual production in the factory. In this case, the manager is trying to assess whether the production process is within control and in accordance with expectations. Any deviation from the actual procedure will indicate that the process is not within control and hence corrective action is required to be taken.
- They give a clue or an insight into some larger problems, which might be happening within the organization. For example, if a manager notices that

the attrition rate is going up sharply, it might give him an insight that either the market for the skills of his employees has become more competitive (that is to say that more players may have entered the market, which requires employees with the same skill set), or that the salary levels of the present organization are way below the prevailing market rates for such skills. This might lead the manager to delve deeper into the problem of attrition, which is only a symptom of a much larger phenomenon of behavioural changes in his own workforce that prefers monetary compensation to loyalty.

Hence, we can see that a modern manager relies heavily on data to take decisions and the means by which he gets the information is through reports. Reports are of the following types:

Scheduled reports: These reports are generated regularly. They are in the nature of daily reports, weekly reports, monthly reports, etc. They contain the latest information and help the manager to understand and analyse the information in the context of the recent past. These reports are the first line of reports and normally the first signs of problems or opportunities can be understood by surfing through these reports.

On-demand reports: These types of reports are unscheduled in nature and are created when the managers need such reports. They help in analysing a particular issue in a greater degree of granularity. These reports are generally the result of a reaction to any event.

Exception reports: In management, exceptions warrant greater attention than any normal event. Exception reports are special reports, which indicate to the manager that some control needs to be exercised to bring an issue under control. For example, if in a company the average absenteeism is 2 per cent and in the last week the average absenteeism is 20 per cent, then an exception report is generated to make the concerned manager aware that something is amiss and needs attention.

Predictive reports: These are special reports, which give the manager a sneak preview of the future. These reports give a scenario of the future and are very useful for the purpose of planning.

Summary reports: These are general reports, which aggregate data and provide a summarized information to the manager so that he may get a macro view of an issue.

Regulatory and statutory reports: These reports are created under the obligations to follow rules and statues. They are primarily meant for external consumption or information needs of regulatory bodies.

Thus, we see that reports reveal to the manager the issues behind a problem and give him with adequate information required for taking decisions. However, information can be of various degrees of value to a manager. A set of information, which he already knows, or incorrect information is of little value to him. So we must understand the meaning of valuable information.

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1.6.2 Information

According to Orlikowski (1992), 'Nothing is more central to an organization's effectiveness than its ability to transmit accurate, relevant, understandable information amongst its employees. All of the advantages of an organization's economy of scale, financial and technical resources, diverse talents, and contacts are of no practical value if the organization's employees are unaware of what other employees require of them.'

What is an information system?

Information systems form a special class of systems whose main objective is to store, retrieve, process, communicate and secure data. Information systems, which help management at different levels to take suitable decisions, are called management information systems. Typically, information systems are housed in a computerized environment/platform, to enable users to get faster and accurate information.

Information systems can be of several types. At the very basic level, it can be used to automate tasks in the office using an office automation system; it can be used to provide the right kind of information to management; or top management can make decisions by using decision support systems. Decision Support Systems are complex systems used at the strategic management level for dealing with unstructured decision problems. Models are used in such decision support systems to help in decision support. MIS is used by the management to acquire information for taking decisions. Typically, MIS does not have a direct decision support role, apart from helping in decision-making by supplying the right information.

Information systems over the years

Information systems have undergone a remarkable transformation in the last forty years of their existence. Initially, information systems were designed to perform a specific task. The objective was to perform a task as quickly as possible with minimum number of errors. The concept of using information systems for taking decisions had not been realized before. Organizations used information systems for data processing only. Be it salary processing or bill processing, information systems previously were focused only on the efficiency of the operation. The people who worked on these systems had a certain knowledge about the system and the user interface of the systems were very basic (character user interface). The output was in the form of salary slips, etc. Processing the data in the most efficient way was the prime focus of such systems. Most of these systems used file-based data storage systems on which a program would work, i.e. the program would be able to access the data and organize it but the data would be stored in a file. The problem with this type of a system was that it led to the replication of data and loss of consistency.

Over the years, information systems have changed. Now the focus is more on helping the management by providing information useful for decision-making. Data processing systems have become obsolete. The focus is on delivering the right information to the right people at the right time. Information systems have become faster, more accurate and user-friendly for easy applicability. People who

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work on information systems nowadays, do not possess much knowledge about the systems per se. They are general users. The systems have become so friendly that they do not require any specialization in information systems. Newer concepts have emerged in information systems to help organizations get better value for their money. Concepts like client–server architecture, networking, distributed computing, centralized database, graphical-user interface and the Internet, have completely transformed information systems. Gone are the bulky mainframe systems requiring loads of money to run. Now more money is required to procure the software than the hardware.

Somogyi (1987) placed the development of information systems in a three-era model. According to him, the initial era of information systems dealt primarily with the Electronic Data Processing (EDP). These systems worked as isolated islands of data processing without any linkage with any other process. Their main focus was on automating routine, repetitive work like payroll preparation, etc., by batch processing of data files. The format of data processing was inflexible and technology was at the forefront. The data processing tasks were tailored to suit technological requirements. This required specialized personnel who understood the complexities of technology; the general management personnel were unable to use it. Ease of use was definitely not a key feature of such systems. With the advent of personal computers and networking, it became easier to provide information to the management for better decision-making. This was the era of MIS in which large databases, which housed all transaction-level data, began to be processed for obtaining significant information for managers. In this era, the business context of information came to the forefront and technology began to be used more as an enabler rather than as an end in itself. The systems began to become user-friendly, so that general management personnel could use it without much difficulty or training. In the modern era, the focus has shifted further to provide strategic value to organizations, so that competitive advantage could be gained through the intervention of information systems. Information systems are now closely integrated with business strategy to get better value. Technology in such systems is used as an enabler and the business strategy takes the centre stage.

Information systems and ICT

Trends in modern business require that Information Systems (IS) should be able to run on Information and Communication Technology (ICT) platforms. Even though an information system in its pristine form does not require any technological intervention, practicality of use in modern business environment forces information systems to run on information and communication technology platforms. The basic reasons for IS to run on ICT are as follows:

- **Timeliness:** ICT-enabled IS can deliver information faster to the decision-maker. In today's competitive environment, speed is the key to success. Information that is relevant now, for decision-making will lose its value if delayed. It will be like listening to 'news' of the previous day. The value of information decreases drastically if it is delayed. The manual systems of IS cannot cope up with the speed required for delivering information and hence, it is essential to take recourse to an ICT-enabled platform.

- **Accuracy:** Information should be accurate and precise, in order to be of any use to the decision-maker. Any information is useless and of no value if found inaccurate.

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Basics of computers

To appreciate MIS and develop a solution-based information technology platform for MIS, one must understand the basics of computers. A brief description of a computer and its allied devices is as follows.

The computer is a device consisting of hardware and software. Hardware is the term used to refer to the physical components of a computer. All electrical, electronic and mechanical components of the computer fall in this category. It includes:

1. **Input/output devices:** These are the devices through which data is entered into the computer and come out as output from the system. The following is a set of I/O devices:

Input devices

- Keyboard
- Mouse
- Light Pen
- Joystick

Output devices

- Display Unit–Cathode Ray Tube based or Light Crystal Display based
- Printer
- Plotter

2. **Central processing unit:** This is the component in which all the data handling—data storage, data processing and data retrieval—is done. This is the main component of a computer. A CPU in a strict sense also indicates a portion of the microprocessor, which plays a central role in the data processing activity; but here, the CPU is used in a more broad sense to refer to the main component of the computer. In this context, the CPU consists of the following:

Microprocessor

- RAM
- ROM
- Hard Disk
- Motherboard
- Bus

Ports: These are physical (and also virtual) junctions of the computer. They are the junctions through which the computer can be connected to other devices or other computers. Ports are of two types: serial and parallel.

3. **Software:** It is the non-physical component of a computer. It is classified into the following two categories:
   (i) *System software:* It is the software which is responsible for the basic functioning of the computer system.
   (ii) *Application software:* It is the software which is responsible for the applications that run on a computer. MIS solutions are examples of application software.

Role of information in decision-making

The decision-making process includes the following stages:

- ***Identification and structuring of problem:*** One needs information to identify a problem and put it in a structured manner.
- ***Putting the problem in a context:*** Without information about the context in which the problem has occurred, one cannot take any decision on it. In a way, the context defines the problem.
- ***Generation of alternatives:*** Information is a key ingredient in the generation of alternatives for decision-making.
- ***Choice of the best alternative:*** Based on the information about the suitability of the alternatives, a choice is made to select the best alternative.

Information is, thus, very important for decision-making. Imagine a simple decision like the one a driver makes when he, on seeing a child crossing the road, applies the brakes to stop a speeding vehicle. The driver's decision to apply the brakes is based on a lot of information processing that happens in his brain. At every stage of the decision-making, he uses the information that he captures visually. All decisions are like this.

First, you get information about a problem, which you then format into a structure; then the information about the context in which the problem has occurred is factored in. As in the above case, if the driver, instead of finding the child in the middle of the road, had found that the child was about to cross the road, would probably not have applied the brakes to stop but would have slowed down, as he would have calculated that by the time the vehicle reaches the crossing, the child would already have cleared the path. So if the problem was structured as 'how to not hit the child crossing the road?,' the decision would be: if the child was at the middle of the road, the driver would have applied brakes; however, had the child been at (say) 90 per cent completion level of crossing the road, the driver would have only slowed down and not applied brakes to stop. Therefore, you can see that the context has a major role in decision-making and information is required both about the problem and the context in which the problem occurred. The next stage for the decision-maker would be to generate alternatives. In the driver's case such possible alternatives would be (a) to stop by braking, (b) to slow down, (c) to take a sharp turn towards left or right to avoid the child, (d) to press the horn so that the child crosses the road fast, (e) to drive the vehicle on to the footpath and off the road to avoid collision, etc. So the decision-maker generates these possible solutions to the problem at hand. Obviously, he needs knowledge and

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information to generate these alternatives. In the case of the above example, for generating alternative (a) i.e., to stop by braking, the driver would need to know the braking distance. If he was unaware of this crucial information, he would not have been able to generate this alternative. So information is vital for generation of alternatives. The decision-maker also needs information about the suitability of each alternative to decide which is the 'best'. In the example, the driver calculates the 'pay-off' for each alternative based on his calculation of the outcome, which again is based on information. He selects the 'best' option, which solves the problem. Thus, you can see that information is the key to the decision-making process. Without information, and the right kind of information, decision-making is not possible.

Therefore, to enable managers to take good decisions, it is important to provide them with the right kind of information. MIS provides this service to the managers, enabling them to take informed decisions.

Subsystems of an information system

Information system is a special type of system, which allows storage, retrieval and processing of data in a secure environment. Logically, the major subsystems of information system are as follows:

- ***Data repository:*** This is a subsystem which is at the core of any information system. Mostly this is a relational database management system, which has preformatted and structured tables for storage of data. These structures are arranged in a way that helps in faster storage and retrieval of data with adequate security.
- ***User interface:*** This subsystem handles the interaction of the system with the user and hence, it has to manage issues related to the display of data on an output medium. This can be either graphical or based on character depending on the level of ease offered to the user.
- ***Network:*** This subsystem ensures communication between the different entities of an information system. It is crucial for the functioning of an information system.
- ***Computer hardware:*** One needs an IT infrastructure to use information systems in an effective manner. Almost all the components of an information system are housed in some kind of computer hardware to enable it to perform the tasks better. For example, an algorithm to find the lowest of three numbers can also be calculated manually; but under a computerized system, it will be much faster and efficient.
- ***System software:*** Some basic software is required for the efficient functioning of information systems. These system software do not directly aid in the functionality of information systems but work as enablers. For example, operating systems, etc.
- **Input/output:** Sometimes, this is clubbed with the user interface (UI) to suggest that I/O functions are handled by UI alone. However, in some systems, I/O may be user-independent; for instance, when an alert is

activated, the input for the alert comes from some other system input rather than a user.

- **Business rule (process):** This is a set of rules which governs how a system should function to imitate the real business process.
- **Algorithm/program/application software:** This is the actual invisible component, which integrates all the components. The logic (business rule) is defined in the program (embedded in it), which enables the functioning of the information system for some specific purpose.

All the above components work in concert to establish a functional information system.

Value of information

The normal mathematical and economical explanation of value of information suggests that if an event occurs whose expectation was low and information of its occurrence is known, then such information is valuable. For example, let us say that the reader of this text gets the information that an earthquake of 10.5 magnitude on the Richter scale is going to hit India and the epicentre of the earthquake will be the very spot in which he is located, then that information is of more value to him than the information (say) that he has to pass his BCA exam to get the BCA degree. In the former case, the information is more valuable to him as he is not expecting it, whereas in the latter case, he already knows the information with certainty and expects it completely and hence the value of such information is less. All market mechanisms work on this model of information.

In a managerial context, the value of information is judged on the basis of the following parameters:

- ***Timeliness:*** Information is valuable to the management only when it can result in some timely intervention/decision. The aspect of time in making decisions is very vital for any value to be attributed to them in management. Information of an event will only be valuable to managers if they have time to react to it. If the reaction time is not available, then the information loses its managerial value.
- ***Presentation:*** Managerial information is valuable when presented in a way that facilitates decision-making. Information should not only be given but also be presented in such a way that the decision-making aspect becomes obvious.
- ***Accuracy:*** Any information to the management is worthless unless accurate.
- ***Context:*** Information for the management is highly contextual. Information is valuable to a manager only if it has a decision-making connotation to it. For example, for a finance manager, any information about the competitor's product is worthless.
- ***Expectation:*** Information is generally more valuable to the management when it generates an expected view or an expected result or an expected reaction. Any information, which is unexpected, carries a higher value. For example, if a manager has made a marketing strategy expecting his

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competitor to launch product A and before the launch he gets the information that the product to be launched by his competitor is not product A but product B, then this information has a greater value for him as it is contrary to his expectation.

1.6.3 System

MIS is not the same as information system. They have two different meanings. Information systems refer to systems that exist in principle but are not put to practice for decision-making. MIS is known as information technology management. This subject of study is not the same as the study of computer science, but it uses computer as an enabling system. Management of IT service is a discipline that is practice-based. MIS is also different from Enterprise Resource Planning (ERP), as ERP is not for decision support. MIS is mainly related to data processing, to find meaningful information for further distribution to other departments in the organization for the purpose of decision-making. The working process of the MIS can be charted as follows:

Data→Information→Communication→Decisions

Data collection includes the use of IT, consisting of computers and telecommunication networks, such as e-mail, voice mail, Internet, and telephone. Computer plays an important role as it provides more quantitative than qualitative data collection, storage and retrieval. Its special features include speed, accuracy and storage of large amount of data. Telecommunication provides the method for one-way or two-way communication by sending and receiving messages using different components of IT such as telephone, computer, processor and printer. Its advantages include saving of money, less time consumption and protection of data and messages.

1.7 COMPUTER-BASED MIS

Investment in information system and technology provides real economic value to the business. The information systems are built and maintained on the assumption that investment in information systems and technology will provide better returns as compared to investments in buildings, machines or other assets. These returns may be in the form of increased productivity, increased revenue, or a strong long-term strategic position in the global market.

From a business point of view, an efficient information system is the most important tool that helps the firms to increase its revenue or decrease costs by providing valuable information to the firm. This valuable information helps managers to make better decisions and improve the execution of business processes. The information system for a supermarket, for example, can provide managers the information like total number of units sold or total sales revenue from a specific product. Based on this information, managers can make better decisions about which products to stock and which products to promote, and thus help to increase the business value.

Every business has its business information value chain (see Figure 1.20) from which valuable information is obtained. In business information value chain, the raw data is collected, validated, transformed and analysed through various

stages and then converted into useful information. This useful information is then disseminated to various business processes, including supply chain management, enterprise management, customer management, and knowledge management; and management activities including planning, coordinating, controlling, modelling and decision-making. This information helps the managers to improve decision-making, enhance organizational performance, and thus increase the firm's profitability. The extent to which an information system can help the business firms in making better decisions, efficient operation of business processes, and firm profitability determines its value to the business.

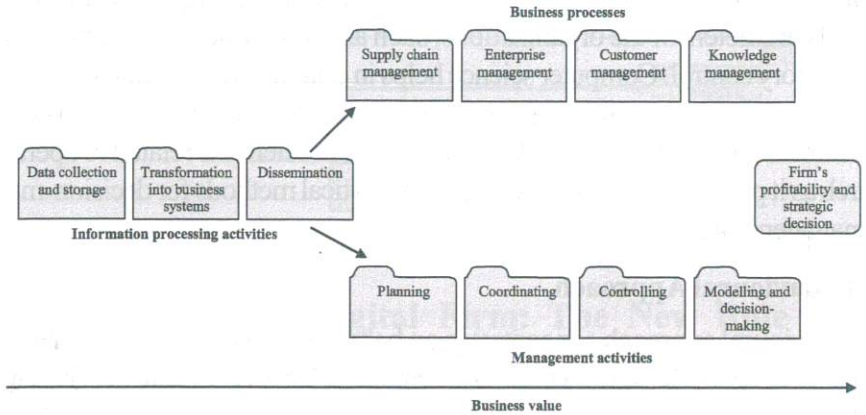

Fig. 1.20 Business Information Value Chain

1.7.1 Contemporary Approaches to Information Systems

As a result of various perspectives on the information systems, its study is a multidisciplinary field. A number of disciplines, including management science, computer science, operations research, sociology, etc., help in providing solutions to the problems and resolving the issues that arise while studying the information systems. In general, this field of study comprises two approaches, namely *technical* and *behavioural* (see Figure 1.21).

Information systems are neither purely social nor purely technical. They not only consist of hardware and software technologies, but also need significant social and intellectual investments to perform in a better way. Therefore, they are also termed as socio-technical systems.

Fig. 1.21 Contemporary Approaches to Information Systems

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The Technical Approach

The technical approach stresses on the use of mathematical models to analyse information systems. It also helps to study the formal capabilities and physical technology of the information systems. Disciplines like computer science, management science, and operations research lead to technical approach.

The three disciplines contribute to the study of information systems in various ways. The operations research methods and techniques, for example, help to solve the decision-making problems by providing the best alternative among various available alternatives. They also use the mathematical techniques to optimize the selected parameters of the organizations, such as transaction costs, transportation and inventory control. Computer science helps in establishing theories and methods of computations. It also provides methods for efficient storage and access of data in the information system. The field of management science is related to operations research as it provides models and common analytical methods for decision-making and management practices.

The Behavioural Approach

The behavioural approach concentrates on behavioural issues such as changes in organizational policies, management and behaviour, that occur while developing and maintaining the information systems. The models used in the technical approach are not sufficient to study these issues. Therefore, behavioural disciplines, including economics, sociology and psychology, help to explore these issues by applying their concepts and methods.

Psychologists study information systems from the perspective of how decision-makers comprehend and make use of the available information. They emphasize more on studying and understanding people and their behaviour. Various techniques are applied to study the thinking pattern and behaviour of individuals in a group, and how people's attitudes are affected by society and organization.

Sociologists study information systems from the viewpoint of how groups and organizations are developed and how systems develop from groups and organizations, and how the systems affect people, groups and organizations.

Economists study information systems from the viewpoint of how they impact the cost and control structures within an organization and within global markets.

Socio-technical Systems

Neither the technical nor the behavioural approach can, by itself, comprehend the information systems efficiently. This is because the success or failure of an information system is neither purely technical nor purely behavioural. Thus, to optimize the performance of the organization, both the approaches are equally considerable. This results in the need of adopting a different view of information systems that combines different approaches. One such view is the socio-technical view of information systems.

From the socio-technical view, the information system is a combination of both the technical and the social systems used in the production. The optimal performance of an organization is obtained by optimizing the technical and social systems together. That is, to optimize the performance of an organization, both the

technical and social systems need to mutually adjust with each other until an acceptable level is achieved (see Figure 1.22). For this, as the technology advances, organizations and individuals must also change, thereby allowing the technology to work and thrive. Similarly, the technology must also be changed and then redesigned in order to fit as per the needs of the organizations and individuals. However, sometimes, we need to de-optimize the technology to obtain the desired fit.

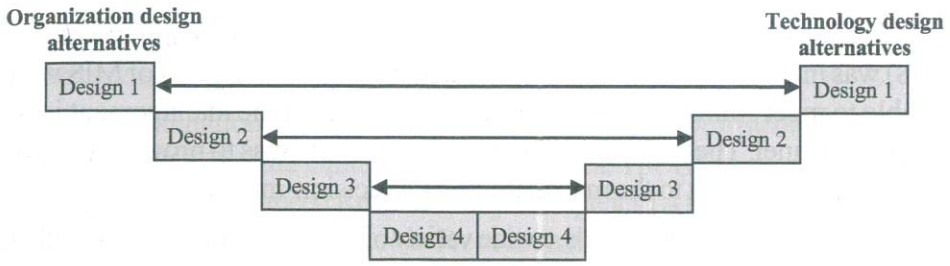

Fig. 1.22 A Socio-technical View of Information Systems

1.7.2 Towards the Digital Firm: The New Role of Information Systems in an Organization

With the advent of digital firms, the role of information systems in modern organizations has become vital. The way managers decide, plan, and manage is directly influenced by the information systems. Moreover, the information systems help to determine what products to be produced, and when, where and how the products are to be produced. Thus, the responsibility of building and managing the information systems cannot be left only up to the technical decision-makers; rather it also requires a major involvement of the organization.

In today's systems, the interdependence between the firm's information systems and its business capabilities has been growing continuously. Any change in business strategy, processes, or rules requires a change in the information system's components, including hardware, software, databases, and telecommunications. Similarly, a change in hardware, software, or telecommunication also affects the business rules, processes, etc.

The widening scope of information systems

With time, the role of computer-based information systems in the organizations has broadened. Figure 1.23 describes the roles of information systems in business and management over the years.

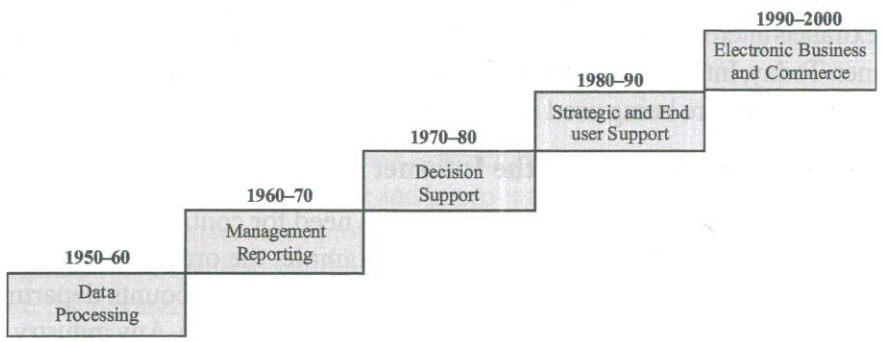

Fig. 1.23 Roles of Information Systems in Business and Management

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During the 1950s and the 1960s, the role of information systems in organizations was quite simple. They were used only for data processing operations, including recordkeeping, transaction processing, traditional accounting applications, and other electronic data processing applications. Then, during the 1960s and the 1970s, the need for studying management information systems (MIS) developed the focus on the use of information systems for developing business applications. These applications produced management reports to provide managers the information required for making decisions.

During the 1970s and the 1980s, the concept of decision support systems (DSS) was introduced because the predefined management reports of MIS were not able to meet some of the decision-making needs of the management in an adequate manner. The new role of information systems was to provide specific and interactive support to the managers in their decision-making process.

During the 1980s and 1990s, a wide variety of information systems, including end-user computing systems, Executive Support Systems (ESS), and Expert Systems (ES), were developed, and as a result several new roles for information systems appeared. The end-user computing systems provided direct computing support for end-user productivity and workgroup collaboration. The users were no longer required to wait for support from the corporate information services departments. The executive support systems (ESS) were developed for the top management because most of the top management executives were not directly using the reports of MIS or the analytical models of DSS. ESS was created to provide critical information required by the top management at the time of their need and also in their preferred formats. In the expert systems (ES), the techniques of artificial intelligence were applied to make the systems act intelligently on behalf of their owners, thereby eliminating the need of human intervention. Today, expert systems can provide the end-users with knowledge-based expert advice in some specific fields.

In the late 1980s, the concept of strategic role for information systems was introduced and it continued through the 1990s. The strategic information systems (SIS) use IT in products, services, or business processes of an organization, and thus help them to gain a competitive advantage. From the mid to the late 1990s, the Enterprise Resource Planning (ERP) systems emerged. An ERP system is an organization-specific form of strategic information system that integrates almost all business functions, such as planning, sales and marketing, inventory control, manufacturing and human resources.

During the 1990s and 2000s, the rapid development of the Internet, intranets, and extranets altered the capabilities of information systems in business in a dramatic manner. Today, Internet-based e-business and e-commerce systems have become very popular and are being used in most business organizations.

The network revolution and the Internet

For most businesses to be successful, there is a need for continuous and prompt flow of information. In an organization, for example, the orders from the sales department are passed on to the shipping department; the accounts department collects statistics and passes them to the management, and so on. Any industry that

wants to be successful in this competitive world needs information to be sent and delivered both constantly and on time. Computer networks help in communicating this information swiftly and effectively.

The term 'network' means an interconnected system of computers. The linking of two or more autonomous computers and other devices with the software for sharing information and hardware resources is called networking. Whenever more than one computer is used at the same location, networking them together facilitates exchange of data and information (data communication) between the connected computers in a fast and efficient manner. This ability to share information is what gives computer networks the power.

The foundation of computer networks was laid in 1969 by the Department of Defense (DOD) of the United States of America. The US government formed an agency named Advanced Research Projects Agency (ARPA) which developed the first network— **A**dvanced **R**esearch **P**rojects **A**gency **NET**work (ARPANET)—to connect computers at various universities and defense agencies. This network was used for exchanging data and messages, playing games, sharing views and ideas on any topic among engineers, students, scientists, etc. The main objective of ARPANET was to develop a network that could continue to function efficiently even in the event of a nuclear attack.

Later in 1980, another agency, the National Science Foundation (NSF), created a new network of computers based on ARPANET, called NSFNET, which turned out to be more efficient and capable. Initially, NSFNET was designed to link five supercomputers situated at the major universities of NSF and allowed only academic research. Over time, this network expanded to include sites for business, universities, government, and so on, and finally became a network consisting of millions of computers, now known as the Internet.

The word 'Internet' is derived from two words: **Inter**connection and **Net**work. It is basically a network of networks that facilitates data transmission and exchange across millions of domestic, academic, business and government networks. It is a global, publicly accessible network that enables sharing of files and other resources using protocols through the transmission media.

Nowadays, the Internet has become one of the necessities for growth and development due to its diverse applications. Companies, individuals (different users) and institutions use the Internet in different ways. Companies carry out business online, including advertising, selling, buying, distributing products and providing sales services. In addition, the Internet has helped business organizations in communications, marketing research, providing access to complex database, and so on.

New options for the organizational design

Organizational designing is the process of structuring an organization, department or division to optimize its performance and improve the growth prospects. It covers the processes and human resource programmes that ensure effective operations within the organization. Organizational design helps to transform the organization's structure, culture, politics and processes to increase its productivity, efficiency and effectiveness.

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In today's turbulent market, to remain viable and competitive, new organizational designs play a very important role. Changes in leadership, shift in strategy and changing factors within an organization are some of the reasons to choose new organizational design. Information systems provide new options for the organizational design, which are explained as follows:

- ***Flattening organizations:*** In digital firms, flattened organizations are more popular. The flattening of organizations provide 'optimal hierarchies' that help in balancing the load of decision-making. The flattened structure provides more decision-making authority to the lower level employees, and the number of levels as well as the employees in the organizational hierarchies is reduced.
- ***Separating work from location:*** The new organizational design has changed the way of doing different types of work in different situations. The factor of distance has been completely eliminated with the help of communication technology. Nowadays, employees can work even from their homes and still collaborate with the team dispersed across the world. Teams can work together towards a single goal, even if they are located in different countries. The new organizational design has also improved productivity. The sales representatives have more time to spend with customers, thereby availing the most recent information. Thus, the companies get more chances to improve their product. Businesses are also much freer to choose the locations from where they want to operate, and can move to more efficient locations. Nowadays, the entire business set-up need not to be at one place. A business, for example, may move its manufacturing part to some low-wage country and maintain its warehouse at some other location.
- ***Increasing flexibility:*** Today's business enterprises are more flexible than the older ones. By flexibility, we mean that the organization is adaptable to diverse situations. An organization faces threats and new changes constantly. Flexibility makes survival and success of the organization in a turbulent environment easy. The more flexible the organization, the better it will respond to changes.
- ***Reorganizing workflows:*** Reorganized workflows help organizations to improve their efficiency by automating the manual tasks. Earlier, a single application used to take a long time to process as it had to move through various channels. However, with the advancement in the business industry, work procedures have been automated and a number of applications can be processed electronically in less time.
- ***Redefining organizational boundaries:*** The emerging digital firm has made it possible to operate the businesses beyond the organizational boundaries. The business can be conducted outside the organization in the same efficient manner like it was conducted inside. It has given birth to the interorganizational systems that enable the information to flow across the boundaries of an organization. They also help organizations to identify new customers and suppliers, and thus redefine the organizational boundaries.

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1.7.3 Learning to Use Information Systems: New Opportunities with Technology

Organizations need different types of information systems to serve various organizational functions and business processes. To fulfil these requirements, systems need enterprise-wide integration. Due to these growing needs, new opportunities and challenges have come into the picture.

New opportunities

The use of information systems in businesses is growing at a faster pace. Due to this, businesses are now getting extraordinary opportunities to apply information systems in every part of the firm to achieve higher levels of productivity and earnings. Today, information systems support nearly all levels and functions in the firm. They act as tools to create value for the firm. In addition, they help managers and employees in the decision-making process by providing valuable information at the right place and at the right time.

The challenge of information systems: Key management issues

Building and using an information system for the organization is not an easy task. The following are the challenges of information systems that managers have to face.

- **The information systems investment challenge:** As discussed earlier, investment in information systems creates value for the firm. However, it has been seen that not all companies get good returns from investments in information systems. Thus, one of the major challenges faced by managers is to ensure that investments in information systems contribute to corporate value. Managers are confronted with a number of questions posed by the senior management which are not easily answerable. Examples of such questions include: Are we obtaining meaningful returns from our investments?; Are our competitors getting better returns?; How can we evaluate our investments in information systems like other investments?
- **The strategic business challenge:** Information systems can make organization and managers more effective only if they are accompanied by complementary assets, such as new business processes, organizational culture, or management behaviour. These complementary assets are required to support the working of technology assets, such as hardware, software, and so on. Unfortunately, most organizations lack complementary assets because of which they do not get significant returns on investments on information systems. Thus, to take full advantage from IT and make organizations more effective and competitive, it is essential to redesign the organizations. The organizations need to develop new business models, change the outdated working rules and business processes.
- **The globalization challenge:** Globalization demands information systems that are capable of endorsing production and sales of goods in a number of countries. Multinational companies maintain their regional offices in many countries. However, because of differences in language, culture and politics in various countries, centralized management control became unmanageable. For the development of integrated, multinational information systems, global

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hardware and software must be developed; global communication standards, cross-cultural accounting and reporting structures should be maintained.

- **IT infrastructure challenge:** One of the major challenges that managers face is to develop an IT infrastructure that is capable of supporting the organization's goals with the changing business conditions and technology. Most companies lack IT platforms that can adapt to changes in business strategies and technologies. Thus, to meet new business and technology challenges, the organizations need to be redesigned and new IT infrastructure need to be developed.
- **The ethics and security challenge:** To develop systems that can be understood, used and controlled by the people and that too in a socially and ethically responsible manner is a major management challenge. Today, more people are employed in collecting, handling and distributing information than in any other occupation. Due to power of information these days, information systems are used in the organizations to automate their core production processes. As a result, our dependency on systems has increased. Apart from IT benefits, information system has raised many ethical and social problems and challenges. The ethical and social issues include threats to intellectual property rights, individual's privacy, elimination of jobs, etc. In addition, the rise of information systems, Internet and Web-enabled technology has introduced threats of unauthorized access to user's data, data theft, data alterations, etc. As information systems are valuable assets for the business organizations, government and daily life, their security, accuracy and reliability must be ensured.

Planning a new Internet business

With the availability of the Internet twenty-four hours a day, Internet businesses are growing at a faster pace. They are becoming popular because they are easy to start with less investments. One need not hire people, or rent a room for the business; also, there is no need to quit the job. In an Internet business, by investing time and small amount of money, one can earn a lot of money.

Apart from its benefits, many Internet businesses that start everyday over the world fail to succeed because of their poor business plan. The success of any business largely depends on the business plan. A business plan is a proposal for a new venture which gives details about the expected needs and results. In an Internet business plan, both the website and the business model are integrated. It also encompasses activities like planning, developing, marketing, and managing a website. It ensures that the right type of customer is targeted, and that the Internet is being fully used as a marketing tool.

The purpose of creating a business plan is not to have an end product; rather it allows thinking effectively about the business. An Internet business plan is composed of ten sections (see Figure 1.24), which are as follows:

1. ***Executive summary:*** This section explains the basics of the entire business plan; for example, the product, the customers and owners, the future of the proposed business, etc. While preparing the executive summary, one should also consider the factor that the user may not be familiar with the Internet.

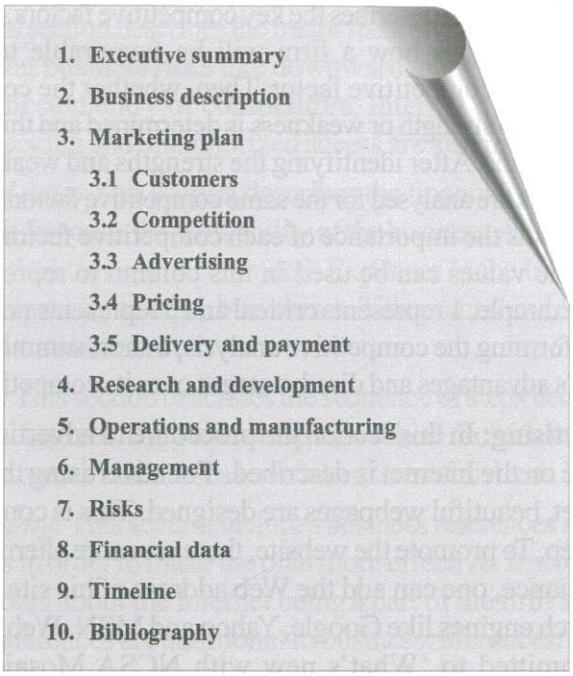

Fig. 1.24Sections of a Business Plan

2. ***Business description:*** In this section, the products and services to be offered by the firm along with the industry-specific information are discussed. All information should be provided in detail. It should also describe how the product and the Internet complement each other.
3. ***Marketing plan:*** This section covers the following:
   - *Customers:* Depending on the target market, the customers along with their characteristics and geographic locations are defined. The number of Internet users is also identified. To identify this, help from various Internet societies and groups can be taken.
   - *Competitors:* To be successful in the market, the competitors or similar types of products are identified and several situations like whether the competitors would compete across the board, or only for some specific products, customers, or locations are examined. To make comparisons with important competitors, a competitive analysis is done. Table 1.3 shows a sample competitive analysis format to compare a firm with two competitors.

Table 1.3 *A Sample of Competitive Analysis Format*

Factor	Me	Strength	Weakness	Competitor A	Competitor B	Importance to customers
Products						
Price						
Quality						
Selection						
Service						
Reliability						
Stability						

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In this table, the first column describes the key competitive factors. The next column labelled as 'Me' mentions how a firm will be favourable to the customers corresponding to each competitive factor. Then, whether the corresponding key factor will be the firm's strength or weakness is determined and this is mentioned in the subsequent columns. After identifying the strengths and weakness of the firm, the major competitors are analysed for the same competitive factors. The last column of the table represents the importance of each competitive factor to the customer. Note that numeric values can be used in this column to represent the relative importance; for example, 1 represents critical and 5 represents not very important. Finally, after performing the competitive analysis, a short summary is written that outlines the firm's advantages and disadvantages over its competitors.

- **Advertising:** In this section the procedure to advertise the product or service on the Internet is described. For advertising the product on the Internet, beautiful webpages are designed. This is considered to be the first step. To promote the website, there are more alternatives available; for instance, one can add the Web address of his site to the databases of search engines like Google, Yahoo and MSN. Web address can also be submitted to 'What's new with NCSA Mosaic' as this gives information about new websites. The address can also be added at the end of each e-mail message.
- **Pricing:** In this section, how the prices for the products or services have to be set are described. For setting the prices, research can be done on what the competitors are charging for similar products or services. If required, a pricing model to justify the firm's prices can be provided on the Internet.
- **Delivery and payment:** In this section, the mode of delivering products and receiving payments is described. For this, a variety of delivery models and online payment methods through credit cards, DigiCash, etc., can be used. In addition, to provide secure transactions online, a number of encryption techniques, such as pretty good privacy (PGP), can be used.

4. ***Research and development:*** This section provides the description about the technical aspects of the project; for example, the current state of the project, type of R & D efforts required to complete the project, and the cost estimation of project completion.
5. ***Operations and manufacturing:*** This section describes the major aspects of business, such as daily operations of the business, the equipment required for the business, etc. In addition, certain other aspects, for example, if the firm needs to use its own Web server or give contract to some other company, whether the staff is knowledgeable about the Internet or they need to be trained in-house are also dealt with.
6. ***Management:*** This section discusses about the management that will run the business. As the business is through the Internet, the business management team should be very capable. To describe the role of the owner is also a part of this section.

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7. ***Risks:*** This section describes the major risks involved in the business. Along with regular business risks like downward industry trends, cost overruns and unexpected entry of competitors, Internet risks, such as computer viruses, hacking and unauthorized access are also included.
8. ***Financial data:*** This section describes the financial matters related to the business. It forecasts the profitability of the business. All financial statements related to the business are included. Expenses in the Internet business are low in comparison to other businesses. This point should be considered in the financial statement.
9. ***Timeline:*** This section describes the sequence of steps necessary to convert a proposal into reality. To develop this schedule, ideas about how much time other online businesses have taken to establish can be taken.
10. ***Bibliography:*** This section includes business references as well as Internet references in order to make the plan more effective. It provides knowledge to the readers about the Internet being a part of the firm's business. These Internet references are additional to business references.

Check Your Progress

5. Define information.
6. Data until organized into a meaningful form cannot help in the _____.
7. The term informa-tion technology refers to which of the following components?
   (a) Software
   (b) Hardware
   (c) Telecommuni-cation
   (d) All of these
8. What is an organization?
9. Organization is a hierarchical structure with different _____ and _____.
10. Which of the following is a unique feature of an organization?
    (a) Hierarchy
    (b) Organizational structure
    (c) Rules and procedures
    (d) None of these
11. How do information systems flatten organizations?
12. Since the cost of _____ and _____ has been rising constantly, today's managers have increased their investments in IT.

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13. Agency cost is also known as _____.
    (a) Transaction cost
    (b) Capital
    (c) Coordination cost
    (d) All of these
14. Name the two models that help in explaining the role of managers.
15. According to Herbert A. Simon, decision-making process can be described in four different stages, namely _____, _____, _____, and _____.
16. According to Henri Fayol, which of the following is a classical role of managers?
    (a) Staffing
    (b) Interpersonal
    (c) Informational
    (d) Decisional
17. Define business strategy.
18. What is a strategic information system?
19. A _____ is an activity for which a firm is the leader.
20. Which of the following is not a primary activity of a firm?
    (a) Operations
    (b) Procurement
    (c) Service
    (d) Sales and marketing
21. The basic activities that constitute a firm are classified into primary activities and _____.
22. List the major factors that have altered the business environment.
23. E-commerce refers to the electronic means to conduct commerce between _____ and _____ over the Internet.
24. _____ intends to execute all the activities in a business enterprise using the Internet and digital technologies.
25. _____ is the process of integrating the economies of countries around the world.
26. Define digital firm.
27. In the business information value chain, raw data is transformed into valuable information through the following process.
    (a) Collection
    (b) Validation
    (c) Transfor - mation
    (d) All of these

28. Which of the following disciplines does the technical approach comprise?
    (a) Computer science
    (b) Mathematical science
    (c) Social science
    d) None of these
29. The _____ is used to explore issues like changes in attitudes, management, and organizational policy with the help of economics, sociology, and psychology.
30. Define socio-technical system.
31. Outline the roles of information systems in business and management over the years.
32. Flexibility helps organizations to be adaptable to _____.
33. List the key management challenges of information systems.
34. _____ is used to compare a firm with various competitors.

1.8 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Organizational information is the information that is required by departments and divisions in an organization. It may contain the number of employees, products, services, and locations, the type of business, turnover and variety of the details of each one of these entities.
2. The four methods of assessing information needs are:
   (a) Asking or interviewing
   (b) Determining from the existing system
   (c) Analysing critical success factors
   (d) Experimentation and modeling
3. Information systems that help management at different levels to take suitable decisions are called Management Information Systems (MIS).
4. A mapping of an information model is called a data model.
5. Information is that data which has been shaped into a form that is meaningful to human beings.
6. Decision-making process
7. (d) All of these
8. An organization can be defined in more than one way. From a technical viewpoint, an organization is a formal social structure that takes inputs from its surrounding environment and transforms these inputs into outputs through the production process. From a behavioural point of view, an organization is a collection of rights, privileges, and responsibilities that is balanced over a period of time.
9. Levels; specialists

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10. (b) Organizational structure
11. In today's organizations, the use of information system increases the efficiency of organizations and help flatten the hierarchies. The IT applications provide the lower level employees with the information they require and they are empowered with the rights to make decisions without supervision. Moreover, the efficiency of managers in making decisions has enhanced because they receive accurate information on time. Therefore, fewer managers are required to supervise more employees than before.
12. Labour; capital
13. (c) Coordination cost
14. The Classical and the Behavioural model help in explaining the role of managers.
15. Intelligence, design, choice, implementation
16. (a) Staffing
17. Business strategy is long-term planning of organizations that determine what products (or services) they provide, the market they compete in, their customers and suppliers, their future plans, etc.
18. Information systems are designed with the goal of solving some problems or seeking new opportunities. The information systems that help organizations to accomplish long-term competitive advantage are known as Strategic Information Systems (SIS).
19. Core competency
20. (b) Procurement
21. Support activities
22. The major factors that have altered the business environment are as follows:
    (a) Internet growth and technology convergence
    (b) Transformation of business enterprise
    (c) Globalization
    (d) Transformation of industrial economy
    (e) The emergence of digital firm
23. Business communications; transactions
24. E-business
25. Globalization
26. A firm in which almost all the relationships between the firm and its employees, suppliers, and customers are managed via digital means is known as a digital firm.
27. (d) All of these
28. (a) Computer science
29. Behavioural approach

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30. A socio-technical system is the combination of social and technical systems. It not only consists of hardware and software technologies, but also has social and intellectual investments to perform in a better way.
31. The roles of information systems in business and management over the years are as follows.
    - 1950s and the 1960s: Data processing
    - 1960s and the 1970s: Management reporting
    - 1970s and the 1980s: Decision support
    - 1980s and the 1990s: Strategic and end-user support
    - 1990s and the 2000s: Electronic business and commerce
32. Diverse situations
33. The key management challenges of information systems are as follows:
    - Information systems' investment challenge
    - The strategic business challenge
    - The globalization challenge
    - The information technology infrastructure challenge
    - The ethics and security challenge
34. Competitive analysis

1.9 SUMMARY

- Organizational information is the information that is required by departments and divisions of an organization. It may contain acount of the employees, products, services, and locations, the type of business, turnover and a variety of details of each one of these entities.
- Functional information is the information required by functional heads to conduct management functions. This information is purely specific to that function and by definition does not have a use elsewhere.
- Strategic information is required for long-term planning and for directing the course the business should take.
- Tactical information is required to take short-term decisions to run the business efficiently. It requires specifically designed processing of data. Most of it can be obtained from day-to-day collection of routine data.
- Information Systems (IS) are a special class of systems that are used for data storage, retrieval, processing, communication and security.
- An information model is a formal representation of any particular entity, be it a project, an object or a system. It includes the entity's various features and characteristics, functions and interrelations. An information model represents all the concepts, rules, operations, limits and specifications to represent data in a stable, sharable and organized structure. A mapping of an information model is called a data model.

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- A facility information model is a model of a facility, with integrated data and documents.
- In this unit, you have learned about information systems, their need in the organizations, management and making strategies. The timely, reliable, and correct information leads to better management decisions, more efficient business processes and higher profitability. Almost all modern firms invest heavily in information system, a set of interrelated components used to collect, process, store, and provide information to the decision-maker. Information is that data which has been shaped into a form that is meaningful to human beings.
- System may be defined as a set of interrelated components that are put together to achieve a common task or goal. Often, a system is composed of several subsystems, which may further be composed of other subsystems.
- Computer-Based Information System (CBIS) uses Information Technology (IT) to perform its various activities. The term IT refers to all the components that a system needs to operate, including software, hardware, and telecommunication. The role and usage of information system is influenced by the needs of organizations, surrounding environment, etc. Introduction of a new information system affects the organization's structure, day-to-day working, performance, productivity, work design, etc.
- From a technical viewpoint, an organization is a formal social structure that takes inputs from its surrounding environment and transforms them into outputs through the production process. From the behavioural point of view, an organization is a collection of rights, privileges, and responsibilities that is balanced over a period of time.
- The Internet has made phenomenal changes in the working of organizations. It provides precise, timely, and accurate information and also helps in effective decision-making. Managers perform a variety of tasks such as making decisions, participating in meetings, writing reports, etc.
- Decision-making is considered as a core managerial function. It is a process of choosing the best alternative from among various alternatives. According to Herbert A. Simon, the decision-making process can be described in four different stages, namely intelligence, design, choice, and implementation. Simon proposed two types of decisions, namely programmed and non-programmed decisions. Gorry and Scott Morton referred to these programmed and non-programmed decisions as structured and unstructured decisions respectively. Decisions that are neither structured nor unstructured are called semi-structured decisions.
- The most commonly used model to support business-level strategies is the Value Chain Model. According to this model, every firm is a sequence of basic activities, with each activity adding some value to its products or services. The basic activities that constitute a firm are classified into primary and support activities. A value web is a group of independent firms that coordinate their value chain, with the use of IT, to generate a product or service for a market collectively.

- Information systems promote synergy by integrating separate business units so that they can act as a whole. Information systems encourage sharing of knowledge, and thus help in creating a core of competency. A core competency is an activity for which a firm is the leader.
- Information systems provide different ways of conducting business that help the organizations to gain a strategic advantage over their competitors and differentiate them from their competitors. Five changes that have altered the business environment are the growth of the Internet and technology convergence, transformation of business enterprises, globalization, transformation of industrial economy, and the emergence of the digital firm.
- Globalization refers to the process of integrating the economies of the countries around the world.
- In today's systems, the interdependence between the firm's information systems and its business capabilities has been growing continuously. The linking of two or more autonomous computers and other devices with the software for sharing information and hardware resources is called networking. The Internet is basically a network of networks that facilitates data transmission and exchange across millions of domestic, academic, business, and government networks.

1.10 KEY TERMS

- **System:** A collection of components that work together to achieve a goal.
- **Digital firm:** Firms that use IT to change their core business processes, manage their customers and suppliers and manage the organization and its employees.
- **Strategic information:** The information needed for long range planning and directing the course a business should take.
- **Tactical information:** The information needed to take short-term decisions to run a business efficiently.
- **Operational Information:** The information needed for day-to-day operations of a business.
- **Information model:** A formal representation of the properties and relationships of an entity integrated with its relevant data and documents.
- **Information management:** Compiling and managing information from various sources and sharing that information with audiences.
- **Transaction costs:** Costs incurred when a firm buys goods which it cannot make itself
- **Agency cost:** Cost incurred in supervising the agents.
- **Decision-making:** The process of choosing the best alternative from among various alternatives.
- **Structured decisions:** Decisions that are well defined, certain, and need little effort from decision-makers.

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- **Unstructured decisions:** Decisions that are not well defined and no certain rules are specified to take such decisions.
- **Semi-structured decisions:** Decisions that are neither structured nor unstructured.
- **Management decision problem:** A situation where the management of a company has to take a decision that requires research.
- **Digital firm:** A firm in which almost all the relationships between the firm and its employees, suppliers, and customers are managed via digital means.
- **Business processes:** A set of logically related activities that are coordinated and focused to accomplish specific business outcomes.
- **Enterprise Resource Planning System:** An organization-specific form of strategic information system that integrates almost all business functions, such as planning, sales and marketing, inventory control, manufacturing, and human resources.
- **Network:** An interconnected system of computers.
- **Networking:** The linking of two or more autonomous computers and other devices with the software for sharing information and hardware resources.
- **Internet:** A network of networks that facilitates data transmission and exchange across millions of domestic, academic, business and government networks.

1.11 SELF-ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What is an information system?
2. What are the components of an IS?
3. What is an information model?
4. What is information management?
5. What is an information system?
6. What is a computer-based information system?
7. Write short notes on the following:
   (a) Transaction cost theory
   (b) Agency theory
   (c) Virtual organizations
   (d) Management decision problems
8. How does Simon classify decisions?
9. According to Henri Fayol, what are the classical functions of managers?
10. What are the roles of managers in organizations?

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11. How have business enterprises changed with rapid changes in the market and competition?
12. What do you understand by business information value chain?
13. Write a short note on the evolution of the Internet.

Long-Answer Questions

1. Explain the need for information systems with respect to organizations.
2. Discuss in detail the various information models.
3. What is the role of information systems in decision-making?
4. What is an organization? Discuss the common and unique features of organizations.
5. Discuss the role of the information system department in an organization.
6. Describe the decision-making process.
7. Discuss Mintzberg's classification of the roles of managers.
8. Explain the major factors that have altered the business environment.
9. What do you understand by organizational design? Discuss the new options for organizational design.
10. Describe some major challenges of information systems.
11. How should one plan before starting a business on the Internet? Discuss the major risks involved in an Internet business.

1.12 FURTHER READING

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UNIT 2 OFFICE AUTOMATION AND FUNDAMENTALS OF COMPUTERS

Structure

2.0 Introduction
2.1 Objectives
2.2 MS WORD 2010
- 2.2.1 Formatting Paragraph and Text in MS Word
- 2.2.2 Shortcut Keys for Various Tasks
- 2.2.3 New Features in Word 2016/ Difference between Word 2010 and 2016

2.3 MS EXCEL 2010
- 2.3.1 Working with Cells
- 2.3.2 Working with Basic Formulae and Charts
- 2.3.3 Modifying and Merging Rows and Columns
- 2.3.4 Adding Spellcheck in Spreadsheet

2.4 MS PowerPoint 2010
- 2.4.1 Creating Presentation and Slides
- 2.4.2 Working with Objects
- 2.4.3 Printing Slides
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2.5 Introduction to Computers
- 2.5.1 Number System for Computers (Binary, Octal, Hexadecimal)
- 2.5.2 Data Representation and Coding Systems (BCD, EBCDIC, ASCII)
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- 2.5.4 Types of Computers (Mini, Micro, Mainframe and Personal Computers)
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2.6 Answers to 'Check Your Progress'
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2.9 Self-Assessment Questions and Exercises
2.10 Further Reading

2.0 INTRODUCTION

Microsoft Word (MS Word or Word) is a program which is used for creating documents. It is used by the organization or standalone user to create documents, reports and notes. Word provides the facilities of creating reports and pictures and thus, manifests your idea on the paper. If you have worked in MS Word earlier, you will notice that a lot of new features are added in MS Word 2010. If you are a beginner, there is no need to worry about learning MS Word. This unit focuses on every aspect of this software from beginning to the expert level. In this, you will learn about the essential features of MS Word, which are needed to enhance the documents. This is one of the common usages of MS Word. This tool of Microsoft Office 2010 also makes creating short reports or lengthy documents, an easy and time saving task.

Microsoft Excel (MS Excel or Excel) is the program that is used for creating the Excel sheets or worksheets. It is used by businessmen and individuals for storing data and its interpretation. It is a part of MS Office, which provides the facilities of storing data in the form of table that contains rows and columns. This program helps in doing the tasks at a faster speed as all the calculations are performed using formulas and functions. If you have used MS Excel 2010 earlier, you will notice that more complicated features have been added. It includes features such as calculation, pivot table, slicers, sparklines and many more. The programming language used by the Excel for applications is Visual Basic. In this unit, we will discuss briefly about the essential features of the MS Excel 2010. We will also learn different features such as file management, information management and shortcuts and tips.

Microsoft PowerPoint (MS PowerPoint or PowerPoint) is a program which is used for creating presentations. It is used by the working professionals, students and politicians for creating attractive presentations. It consists of information in the form of text and various visual aids such as graphics, pictures and video, which keeps the audience interested. This way of presenting information and sharing of ideas increases visual literacy among users. This unit emphasizes on each and every aspect of creating and designing presentations. In this unit, you will learn about the essential features of PowerPoint, different methods of formatting and ways to enhance your presentation. Moreover, it will make you an expert in delivering the presentation and convincing the audience. PowerPoint provides the facilities of creating the presentation and manifests the idea in front of audience in an organized and easily understandable way.

Digital computers are commonly used for data processing and solving problems using programs. These operate by counting digits in the binary form and processing data in discrete form. Hybrid computers are generally used for weather forecasting and industrial process control. A number system that uses only two digits, 0 and 1 is called the binary number system. A transistor can be made to operate either in cut-off or saturation; a magnetic tape can be either magnetized or non-magnetized; a signal can be either HIGH or LOW; a punched tape can have a hole or no hole. You will also understand data representation and coding system. Memory in the computer system is required for storage and subsequent retrieval of instructions and data. We will also learn about the Central Processing Unit or CPU that contains several registers for storing data and instructions. Programs and data must be entered into the computer memory for processing, and results obtained from computations must be displayed or recorded for the user's benefit. An Optical Barcode Reader or OBR uses laser beam technology. The laser beam is moved across the pattern of bars in a barcode. Mainframe computers support a number of users to access a variety of software applications. They are also called organizational computers because they are used in large organizations.

In this unit, you will learn about the MS Word 2010, MS Excel 2010, MS PowerPoint 2010 and introduction to computers.

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2.1 OBJECTIVES

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

- Discuss the significant features of MS Word 2010
- Format word documents using bullets, numbering and styles with the help of illustrations
- Enhance the documents using table, border, page setup, header and footer
- Manage file and create secured document
- Discuss the important features of MS Excel 2010
- Understand the working with cells and basic formulae and charts
- Insert data and calculate the values using formula and functions
- Apply quick style to charts, and tables
- Discuss important features of Microsoft PowerPoint 2010
- Understand the introduction of computers

2.2 MS WORD 2010

Opening, Creating, Saving and Working with Documents

Microsoft Word is used for the creation of documents. It is the most commonly used format for storing information and sending it through e-mails. There are several interactive features in MS Word 2010 that help in making the documents productive and innovative. Here, we will explore some features such as the management of various files in the word documents, management of the information in a secured way and various shortcuts and tips to access different commands.

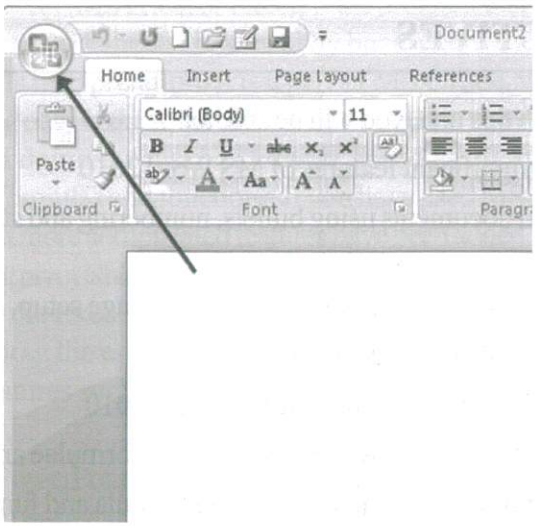
File Management

File management provides the facility to organize the files by saving them in the computer and drives such as disk drive, USB drive, etc. The saved file can then be searched and opened later on. Also, the files can be moved from one location to another as the need be. To better understand the features and functions included in file management, it is essential for you to know about the **File** menu of MS Word 2010.

To make you comfortable with the various aspects of file management, a detailed description of the **File** menu is given below:

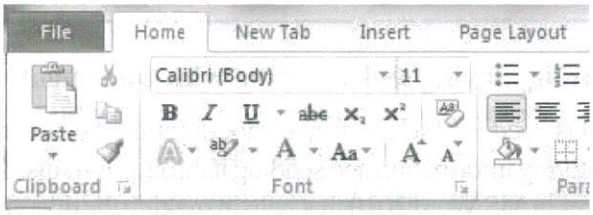
File Menu

In the previous version of Microsoft Office there was no **File Menu**. Instead, there was an **Office Button.** This is shown in the following screenshot.



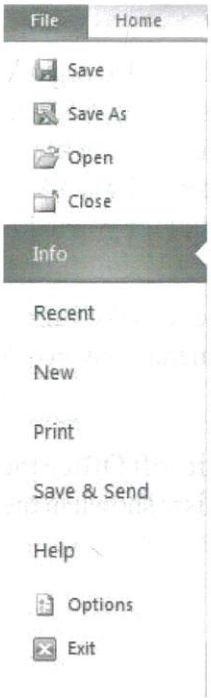
The Office Button has been replaced by the **File Menu** in Microsoft Office 2010. Whenever **File Menu** is clicked, a backstage view of Microsoft Office is visible. In MS Office 2010 **File Menu,** allows users to easily access frequently used commands.

A screenshot displaying **File Menu** is shown below:



When you click on the **File** menu, various options related to the file are displayed.

A screenshot displaying the options is shown below:



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Creating a new document

To create a new document in MS Word. Follow the following steps.

1. Go to the file menu in the ribbon interface.
2. Click on New option, you will see the new blank document template.

Inside **File** tab you will find six main sections and six buttons.

The six sections present inside **File** are as follows:

- **Info: Info** section gives important information related to file, by specifying its properties. It enables youto protect documents, check for issues and manage versions.
- **Recent: The Recent** section is by default selected is. This section shows all the **Recent Documents** and **Recent Places**. **Recent Documents** are the word documents which can be opened just by clicking. **Recent Places** are the places where these recent documents are being saved. If a user wants to quickly access recent documents, he should check the option **Quickly access this number of Recent Documents** by selecting the number from a drop down box. All documents will appear on the left hand side. You can recover documents which have not been saved by clicking **Recover Unsaved Documents** button.
- **New: New** section helps you to create new documents. By default, the **Blank Document** is the template selected, however the user can choose any template,.
- **Print: Print** section enables you to print the files with the available settings and a preview of the **Print** section is shown on the right hand side of the window.
- **Save & Send:** There are different options present inside **Save & Send** option. **Send Using E-mail** allows user to send the file with the help of email. In **Save to Web** option you need to login with the help of Windows Live ID. After that, you click on **Save As** option to save the file at the location which you want. The **Save to SharePoint** option is similar to **Save to Web** option. In **Publish as Blog Post option,** user can create blog post by incorporating the present document. This helps to publish blogging contents online. In **Change File Type** option, the user can change the extension of the file type. In **Create PDF/XPS Document** option user can convert word document to PDF or XPS format.
- **Help:** In case of any need, the user can click on **Help** button. The **Help** button also lets you know about updates related to the Office.

The six buttons which are present inside **File** are as follows:

- **Save: Save** button helps in saving the document which you are, currently working upon. Suppose, you are saving the document for the first time then it will ask you the location where you want to save it..
- **Save As: Save As** button is used when you want to rename the document and save it in another location.
- **Open: Open** button is used when you want to open a document which has already been saved.
- **Close: Close** button is used when you want to close the documents which you are currently working upon.
- **Options:** Options button is used when the user wants to apply various Word options related to the file.
- **Exit: Exit** button is used to exit documents. Before you exit, you are asked whether you want to save the document or not.

Saving a document

In MS Word 2010, files are saved in the default format, which is .docx. This is because .docx format is more secured and damages can be easily recovered. Some other formats of saving the files in Microsoft Word are .docm, .dotx and .dotm, which are explained as follows:

.docm file format is used when the document is to be saved in macro-enabled documents.

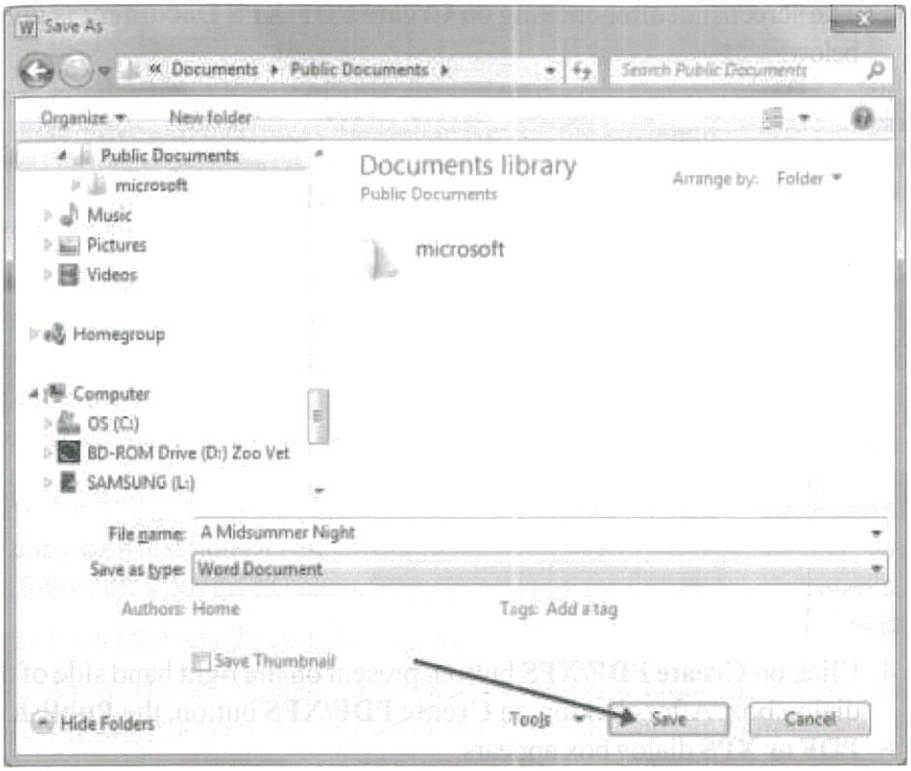
.dotx file format is used when the document is to be saved in document template.

.dotm file format is used when the document is to be saved in macro-enabled template.

There are many ways of saving the files but these are optimized for the specific uses.

Steps to save the documents are as follows:

1. Click the **File** tab which is present on the left hand side of the ribbon.
2. Click the **Save As** option.
3. Select the drive and folder where you want to save the file.
4. Go to the **File name** textbox to write the name of the file.
5. Select the format in which you want to save the File. By default, the file format in which the file is saved is .docx.
6. Click on **Save** button to save the file.



This can also be done by clicking the **Save icon** present on the **Quick Access Toolbar.** The keyboard shortcut for saving a word document is Ctrl+S.

Saving a document in PDF or XPS format

There are two methods for saving a document in PDF or XPS format, both are given below:

1. One method of saving the file in Pdf or Xps format is with the help of **Save As** button.
2. Another method of saving the file in Pdf or Xps format is with the help of **Save & Send** section.

Here are the steps for saving a document in PDF or XPS format using **Save As** option:

1. Go to the **File** tab which is present in the ribbon.
2. Inside **File** tab, click on the button **Save As**. The **Save As** dialog box appears.
3. Choose PDF extension from **Save as type** which will save the word file in PDF format. In order to save the file as an XPS Document, choose XPS Document extension.

To save a document in PDF or XPS format using **Save & Send** option, follow the following steps:

1. Go to the **File** tab which is present in the ribbon.
2. Inside **File** tab click on the section **Send & Save**.
3. Click on the button **Create PDF/XPS Document**.

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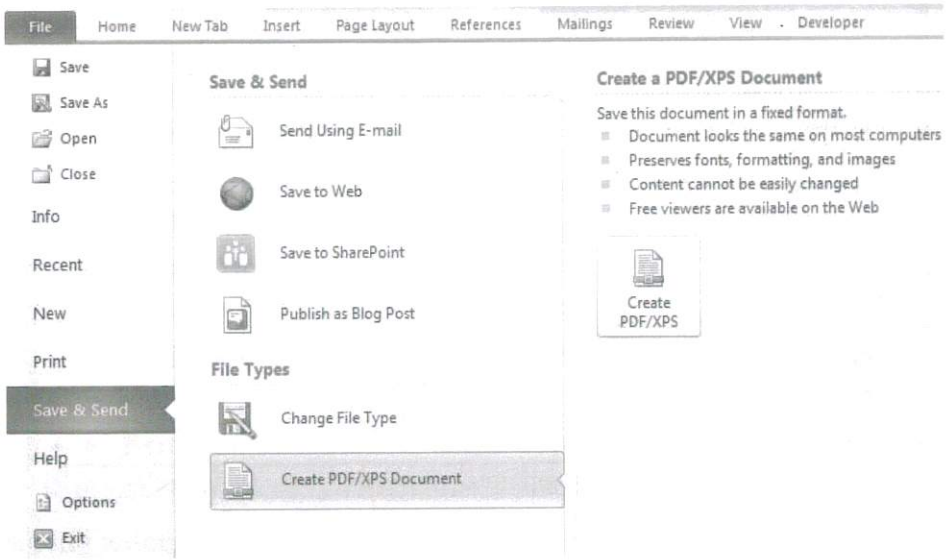
The screenshot after clicking on **Create PDF/XPS Document** is given below:



4. Click on **Create PDF/XPS** button, present on the right hand side of the dialog box. After clicking on **Create PDF/XPS** button, the **Publish as PDF or XPS** dialog box appears.
5. After that Click on **Publish** button to publish the document in PDF format. If the user wants to publish the document in XPS format then user should choose **XPS Document** from the **Save as type** drop box.

Moving file into a specific folder

Steps to move the file into a specific folder are as follows:

1. Clickthe file which you want to move.
2. Hold the left click of the mouse on the file and drag that file to the specific folder.

Opening the document

Steps to open documents are as follows:

1. Click the **File** tab which is present on the left hand side of the ribbon.
2. Click the option **Open**.
3. Select the location of the file, that is, the appropriate drive and folder from where you want to open the file.
4. Select the file which you want to open.
5. Click on **Open** button to open the file.

Deleting Text

You can delete or remove the text from the document that is no longer required. To do so follow the given steps.

- For deleting text to the Left of the insertion point, press the Backspace Key on the keyboard.

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- For deleting text to the Right of the insertion point, press the Delete Key on the keyboard.
- For deleting a Range of Text, first select the text that you want to delete or remove and then press the Delete Key on the keyboard.

Copying and Moving Text

You can copy and paste the same text that exists in your opened document to other regions or locations of the same document. Moreover, you can copy and paste the text to another document also. This saves your time. MS Word also allows you to move the selected text from one region of the document to another region as per your requirement. To do this just cut and paste or drag and drop the selected text to the desired location or region.

Copying and Pasting Text

By copying a text you can create duplicate or replica of the selected text. To do this follow the steps given below.

1. Select the text that is to be copied.
2. On the Home Tab, click on the Copy command or simultaneously press the CTRL + Ckeys on the keyboard. Alternatively, you can right-click on the selected text and then select Copy.
3. Position the insertion point in the text where the text has to be copied.
4. On the Home Tab, click on the Paste command or simultaneously press the CTRL + V keys on the keyboard.
5. The copied and pasted text will appear at the position specified by you.

Cut and Paste Text

1. Select the range of text that you have to cut and move to the new specified position. On the Home Tab, click on the Cut command or simultaneously press the CTRL + X keys on the keyboard. Alternatively, you can right-click on the selected text and then select Cut command.
2. Position the insertion point in the document where the text has to be moved. On the Home Tab, click on the Paste command or simultaneously press the CTRL + V keys on the keyboard. The text will be moved to the specified location in the document.

Find and Replace

In the document let us use the Find and Replace command for changing the word 'Word' to 'MS Word'. To do so, follow the steps given below.

1. On the Home Tab, click on the Replace command.
2. When you click on the Replace command, then the Find and Replace dialog box will appear.
3. In the Find what: field, type the text (in our case 'Word') that you want to find in the document.

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4. In the Replace with: field, type the text (in our case 'MS Word') with which you want to replace. Now click on Find Next. Now press 'Replace' to change the word.
5. MS Word will quickly find the first instance of the text 'Word' and highlight it in gray color.
6. Now check your document to **Review** the text and confirm that the word you wanted to replace is done successfully. If there are more than one word to be replaced in the document then select the command '**Replace All**'. All the words in the document will be replaced and an update will be displayed on the screen that how many words are changed and replaced.

Printing a new document

After creating the document in MS Word 2010, you can **save, share** and **print your document** to view it offline. MS Word provides various options for printing the document. You can preview your document before printing using the Print pane so that you can make necessary modifications.

The MS Word provides the very significant feature 'Custom Printing' which helps you in printing only the part text or selected text of the document when you do not want to print the whole or entire document, because by printing unnecessary pages you will be wasting the printing paper. Using the Custom Printing option you can print either several or numerous individual or separate pages or a specified range of pages. Word permits you to specify or identify and select the exact pages from the document for printing.

Printing Document using Custom Print

To print a specific range of pages and individual pages you have to enter the individual page numbers and the range of page numbers. Remember that each entry has to be separated with a comma, for example 2, 5, 8, 15, 20-25, 41-54, and so on.

1. Click on the **File Tab** to open the **Backstage view**. Click on the **option Print**.
2. The **Print pane dialog box** will appear. Click on the **arrow** that appears next to the **field 'Print All Pages'** in the **'Settings' option**. A **menu** will be displayed, select the **option 'Custom Print'**.
3. To do **Custom Printing**, in the **field 'Pages:'** enter the page numbers (individual page numbers or range of page numbers) that has to be printed.
4. Click on **'Print'** to print the preferred pages.

Print Preview

The 'Print Preview' feature of MS Word helps you to view on the screen how the printed version of the document would look like before printing a hard copy. In latest versions of the MS Word (MS Word 2010 Onwards), there is 'NO' Print Preview Tab or Option. As an alternative, click on the **File Tab** then on the **option Print** from the **menu** that appears on the **left side**. The **Print pane** will be displayed. In the **Print pane**, click on the **'Page Setup' option** to open **Page setup dialog box**. In the **Page setup dialog box** define the **Margins**, **Paper**

Size and **Layout options** for **setting the document text** so that the text remains within the printable area.

The Ribbon Interface

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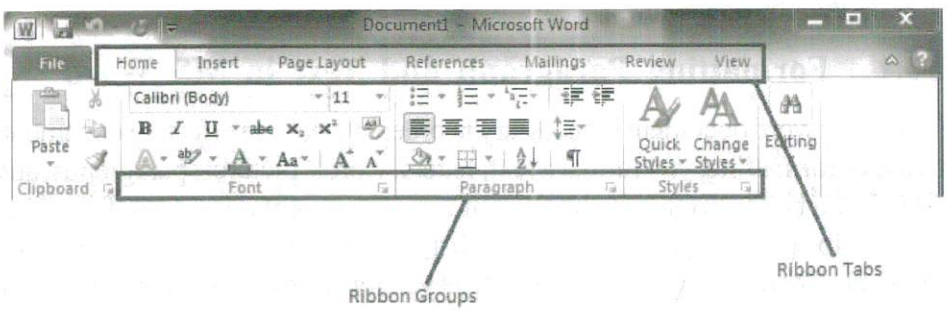
Ribbon View is a substitute that provides the facilities of accessing the commands for applications. It is organized using a horizontal bar. It provides an easy way to access the commands, as all the commands are organized using tabs and groups. With the help of Ribbon, performing various actions to the Office application is easy. Ribbon is dynamic in nature, which implies that behavior changes as the size of Microsoft Office changes.

'Ribbon' is a set of toolbars which displays the commands and tools for performing various tasks. In Microsoft Office 2003, user worked with the classic drop down menu and toolbar and users were able to work with them easily and quickly. With the release of Microsoft Office 2007, the new term 'Ribbon' was proposed that refers its own implementation of tabbed toolbars bearing heterogeneous controls, known as 'The Fluent User Interface', which swapped the menus and toolbars with a single 'Office Menu'. MS Word, PowerPoint, Access and Excel implemented 'Ribbon' in MS office 2007.

With the release of MS Office 2010, however, 'ribbon' was implemented in the rest of the MS Office applications and added end user customization support for its end user. MS Office 2010 ribbon is great, flexible and easy to use.

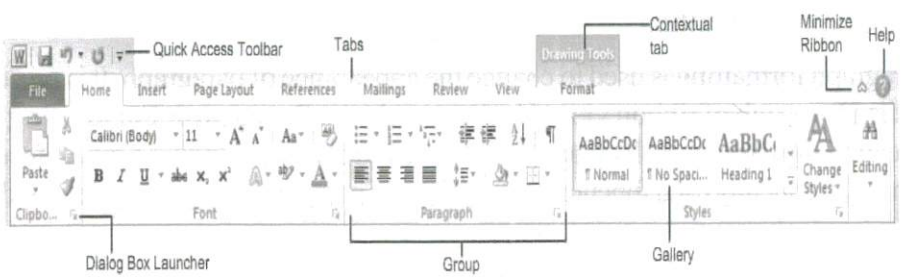
Screenshot for **Ribbon** is as shown:



If you click on any tab or groups, each button and each dropdown menu will perform different actions

For example: When one clicks on the **Home** tab or any other tab, various options are displayed. With the help of these options, one can change the Formatting, Orientation, Layout, Caption, and Proofing of the MS Office Application.

As an example in MS Word 2010, the labeling of the commands and menus is as shown in the screenshot:



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- **Tab:** It shows different types of commands for creating MS Offices applications. You can see the commands by clicking on the particular tab.
- **Quick Access Toolbar:** It is a way to provide quick access view to the most frequently used commands. By default, **Save**, **Undo** and **Redo** buttons are visible on the **Quick Access Toolbar**.
- **Contextual Tabs:** It displays the Commands for a particular selected object. When the user draws any shape, a Contextual tab called **Drawing Tools** appears.
- **Minimize Ribbon:** You can minimize the ribbon in the following ways:
  - By clicking on **minimize ribbon** button.
  - By double clicking the tab on the **ribbon**.
  - By right clicking the tab from the **contextual menu** and selecting **minimize ribbon** button.
  - By pressing **Ctrl+F1** button.
- **Help:** For getting any help, you can click on **Help** button or by clicking on the **File** tab and selecting **Help** from the menu.
- **Dialog Box launcher:** You can see the **Dialog box launcher** or the **Task pane** by clicking on the **Clipboard Task Pane**.
- **Group:** Set of all correlated commands which appear in each tab.
- **Gallery:** Gallery contains the option list and additional choices are displayed as thumbnail preview.

2.2.1 Formatting Paragraph and Text in MS Word

Formatting word document is necessary in order to create an effective document. In case of formatting, you format a text, letters, words, pictures, paragraphs, and so on. It can be applied to any portions of word documents. There are four types in which formatting are classified, which are character, document, section and paragraph. There are various tools which let you format the word documents. You can apply font and paragraph formatting; create bullet and numbering to show the information in point. You can also apply various styles to enhance the text. In this section, you will learn to format a word document by applying different formatting effects.

Paragraph and Font Formatting

Font and paragraph formatting is one of the most important styles of formatting. If you do not apply any style, then font and paragraph formatting are applied by default. It is applied to keep the documents simple and appealing.

Paragraph Formatting

Paragraph formatting is used to change the appearance of paragraph. It is present in the **Home** tab of ribbon view. You can apply the **Paragraph Formatting** by selecting the paragraph. It contains various controls for providing a quick access to many frequently used functions. All options of paragraph formatting are found in the paragraph group.

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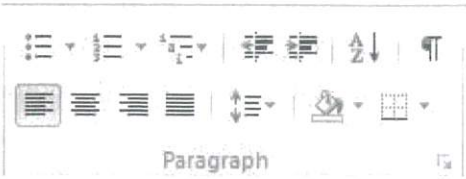
The screenshot of **Paragraph Formatting** is as shown:



The available **buttons and icons** of the Paragraph Formatting toolbar are shown:

- **Bullets** button of the formatting toolbar helps in creating and removing the bullets of the selected paragraph.
- **Numbering** button of the formatting toolbar helps in creating and removing the numbers of the selected paragraph.
- **Multilevel list** button of the formatting toolbar provides you the facility of adding numbered lists of items, using multiple levels.
- **Decrease Indent** button decreases the indentation level of the paragraph.
- **Increase Indent** button increases the indentation level of the paragraph.
- **Sort** button helps in sorting the text, number and date to either ascending or descending order.
- **Show/Hide** shows or hides the formatting symbols of various sections of adocument. Arrow symbol denotes tab and dot denotes space. It is set from left to right direction.
- **Align Text Left** button of the formatting toolbar helps in alignment of text, number, paragraph and object to left.
- **Align Center** button of the formatting toolbar helps in alignment of text, number, paragraph and object to center.
- **Align Text Right** button of the formatting toolbar helps in alignment of text, number, paragraph and object to right.
- **Align Justify** button of the formatting toolbar helps in alignment of text, number, paragraph and object to both left and right margins.
- **Line and Paragraph spacing** of the dropdown menu helps in changing the amount of space between the paragraphs when selected. You can choose any space by clicking on the dropdown menu.
- **Shading** dropdown box helps you to add colored background to the area of text which is selected.

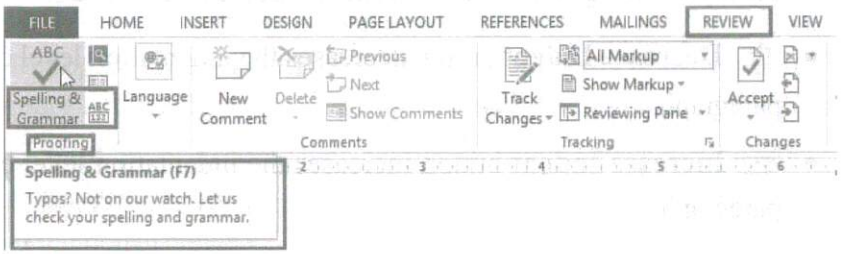
- **Bottom Border** dropdown box helps in selecting the borders from optionsin the dropdown menu. By default, "Bottom Border" is selected. You can change border to Top Border, Left Border, Right Border etc. You can add and remove the border around any texts, pictures or paragraphs.

Spelling and Grammar Checking

MS Word provides significant feature **'Proofing'** for checking the text in the document by using the **option 'Spelling & Grammar'**. If you have made mistakes in the document while typing the text then you can use the numerous proofing features provides by MS Word to produce error-free and professional documents. You can check the spellings in the document and after making necessary correction you can change the corrected spelling in the whole document.

Running a Spelling and Grammar Check

1. To start the proofing of the document text, on the **Review Tab** go to the **Proofing group option** and then select the command **Spelling & Grammar**.



2. The **Spelling pane** will be displayed on the right side of the screen. MS Word will provide **one or more suggestions** for **every error** in the **document text**. Select the correct suggestion **to modify the error** if you want and then click on **'Change'** to **change this specific error** or click on **'Change All'** to **modify** the **similar error in the whole document**. If you **do not want to modify or change the error** then click on **'Ignore' for ignoring this error** or click on **'Ignore All' for ignoring the similar errors in the whole document**. Generally, the **error is highlighted** by a **red line** in the document text.
3. MS Word will go through each error in the document till you review all the errors in the current document. When you **review the last error** in the document then the dialog box will be displayed on the screen to confirm that the checking of spelling and grammar is now completed. Click on **OK**.
4. You can also manually modify or correct the spelling errors in the document when no suggestions are provided by MS Word.

Ignoring Errors

Do not entirely depend upon the Spelling and Grammar check as it may not be correct always. Essentially while checking errors in grammar, it is possible that MS Word may not notice various grammatical errors. It is also possible that at times the Spelling and Grammar check option may mark any spelling as incorrect while actually

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it is correct, for example name of people or place which is not included in the MS Word predefined dictionary. Use the following options for checking a spelling or grammatical error.

Checking 'Spelling Errors'

- **Ignore:** When you click on **'Ignore' option** then the MS Word will **skip checking the marked word,** i.e., it will not be changed.
- **Ignore All:** When you click on **'Ignore All' option** then the MS Word will not only **skip checking the marked word,** i.e., it will not be changed, but it will also **skip checking all other occurrences or instances** of the **similar word** in the current MS Word document.
- **Add:** When you click on **'Add' option** then MS Word will **add the marked word** to the **existing predefined dictionary** so that it will **not be marked as error** again. Before clicking on the **Add option** check the **spelling of the word** to ensure that the **marked word** is **spelled** accurately.

Checking 'Grammar Errors'

MS Word provides detailed explanation for each marked 'Grammar Error' that why it is incorrect. It also displays some related example sentences or phrases to explain the concept, as shown in the given Illustration. These examples will help you in determining whether to change the marked sentence or phrase by clicking on the Change option or to ignore it by clicking on the Ignore option.

Change: When you click on the Change option then MS Word will modify or change the marked sentence or phrase in the document with the suggestion that you have selected.

Ignore: When you click on the Ignore option then MS Word will skip checking the word or phrase in the document without making any change or modification to it.

Automatic Spelling and Grammar Checking

By default, MS Word will automatically check the Spelling and Grammar errors in the document. Hence, there is no need to perform a separate checking in the document for spelling and grammar. MS Word indicates these errors by distinct colored and wavy lines.

- If the **word** is **marked** with the **red wavy line** then it indicates that it is a misspelled word, i.e., the spelling of the marked word is incorrect.
- If the **word or sentence** is **marked** with the **blue wavy line** then it indicates that it is a grammatical error, i.e., either the usage of word is grammatically incorrect or the sentence includes misused words.

The misused word is also termed as a **'contextual spelling error'**. This term is used when the spelling of the marked word is correct but it is used incorrectly. For example, while writing a letter if you **start** with the **phrase 'Deer Mr./Ms. XYZ'** then the **word 'Deer'** will be a misused word or a contextual spelling error. The spelling of the word Deer is correct but in the letter it is used at incorrect place. The correct word to be used is 'Dear'.

Correcting the Spelling Errors

To correct the Spelling Errors, follow the steps given below.

1. Place the insertion point at the word marked as error by MS Word. Now right-click the marked underlined word. The menu with spelling suggestions will appear.
2. Select the spelling that is correct for your document from the list of suggested spellings as shown below in the Illustration.
3. MS Word will change the marked word with the corrected spelling in the document.

Word Count

Total number of words in a Word document is displayed on the status bar at the bottom of the Word window. If it is not displaying then right-click the status bar and then click Word Count.

1. Go to the **File** tab
2. Go to the **Save As**

The screenshot of

Table of Contents (TOC)

Table of Contents gives a quick reference point or an abstract overview to the reader where the reader can find data or content.

Inserting Table of Contents:

TOC is inserted in the document at the position, where the cursor is placed and it is not inserted from the starting place of the document.

Steps to insert table of content are as follows:

1. Create a blank document.
2. Click on **References** tab from the **Ribbon** view.
3. Click on the **Table of Content** option under **Table of Content** group. A dialog box opens which shows different type of **Table of Content** options.

Table of Content Fields: This is another method of adding fields in Table of Content.

Steps to add entries in Table of Content are as follows:

1. Click on the **Insert** tab.
2. Click on the **Quick Parts** which comes under **Text** group and select the option **Field**.
3. Then, a **Field** dialog box opens.
4. Select the option **TC.**Then type some text in **Text Entry** text box and click **OK** button.

5. For displaying the entries, click on the **Table of Content** option in the **Reference** tab. Then, click on the option **Insert Table of Contents.**
6. Then, a **Table of Content** dialog box opens.
7. Click on the **Options** in this dialog box, then, a **Table of Content Options** dialog box opens.
8. Uncheck the **Styles** and check the **Table entry fields** options and then click **OK**button.

Updating the Table of Contents: If you want to change the some content in the document then you can update it by using following steps:

1. Click on the **Reference** tab. Select **Table of Contents** under it and choose any one style for creating TOC. An example of **Table of Contents** is as shown:

   Contents

   9. Updating The Table Of Contents
      7
   12. Adding Entries To A Table Of Contents
      7
   14. Removing Entries From A Table Of Contents
      8

2. Then click on **Update Table**, a dialog box **Update Table of Contents** will be opened click on the **OK** button of that dialog box.
3. Update the content of table according to your need.

Removing entries from the Table of Content: You can also remove the entries from the Table of Contents.

Steps to remove entries from the Table of Content are as follows:

1. Click on the **Reference** tab.
2. Click on **Add Text** option under the **Table of Contents** group.

Working with Tables, Columns and Sections

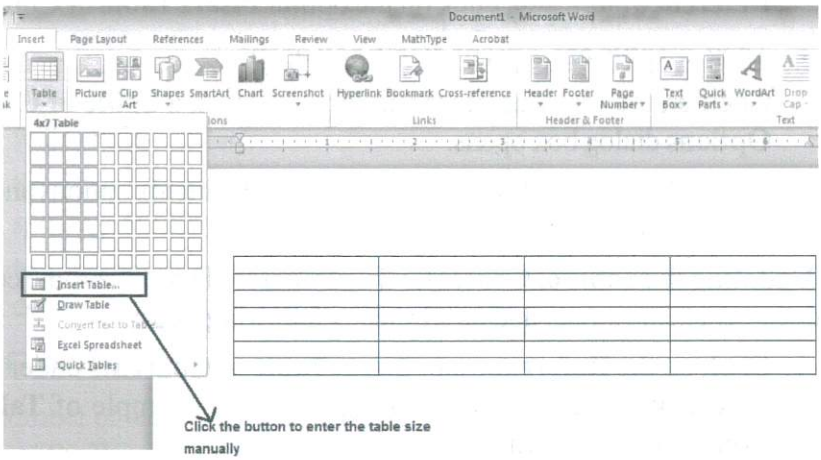
Table

Table consists of the rows and columns. Rows are horizontal and columns are vertical. At the intersection of the rows and column there is a cell which contains the text. We can format the tables according to our requirements.

Creating a table

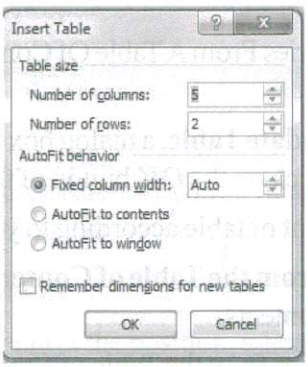
- Go to the **Insert** tab and click on the **Table** option.
- Move your cursor over the grid, the table will appear in the document. We can add the desired number of rows and columns in the table. Left click on the grid when the size of the table is appropriate.

The screenshot of the table created using the grid is as shown:



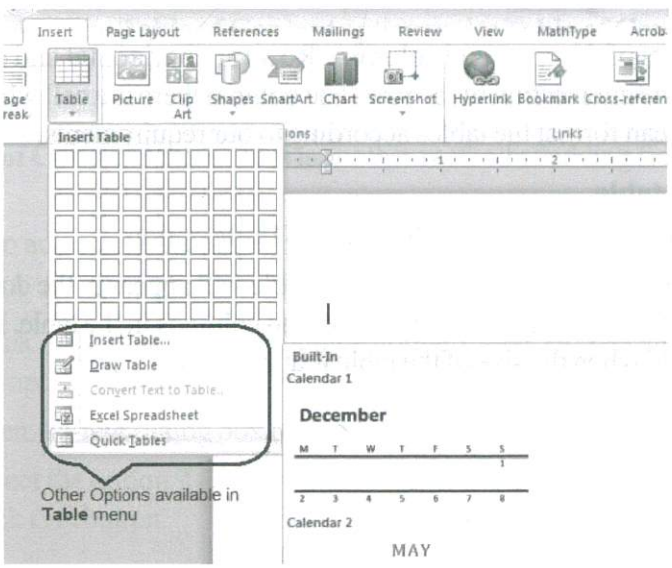
- Sometimes, the required table might be greater in size than that is available in the grid. In that case, click on the **Insert Table** button and enter the size manually.

The screenshot of the table created manually is as shown:



- Below the grid, there are other options that can be used to design the table according to the requirement.

The screenshot showing the other options available for creating a table is as shown:



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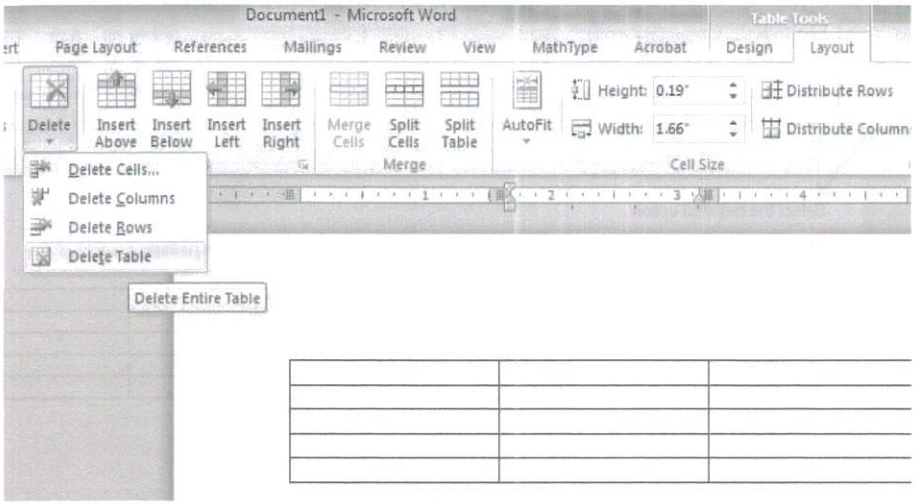
Deleting the table

- Click on the table. Table layout will be displayed on the top.
- Click on the **Delete** button.
- Select the **Layout** tab if this is not already selected.
- Click on the **Delete Table** button. This will delete the table. Other actions can also be performed on the table according to the requirement.

The screenshot of **Delete Table**is as shown:

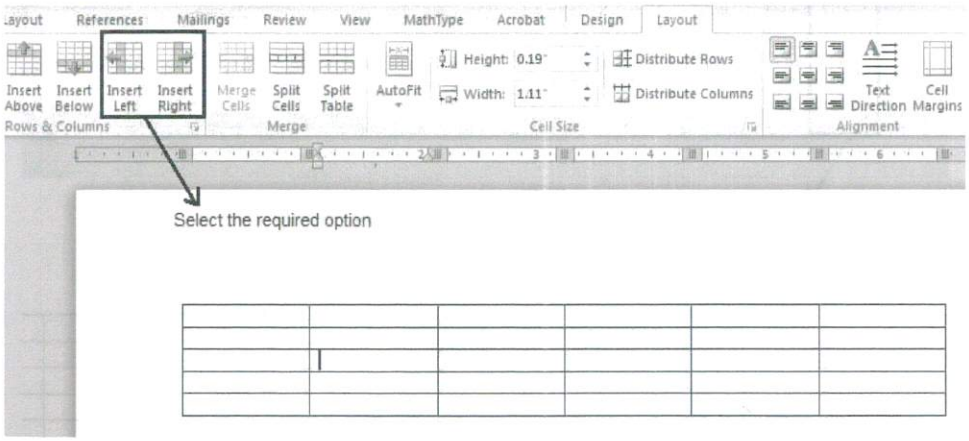


Column

Insert Column

- Click on the table. Go to the **Layout** tab.
- In the **Layout** tab, go to the **Rows and Columns** section.
- Click on **Insert Right** or **Insert Left** for inserting a column on the left and right side of the particular column.

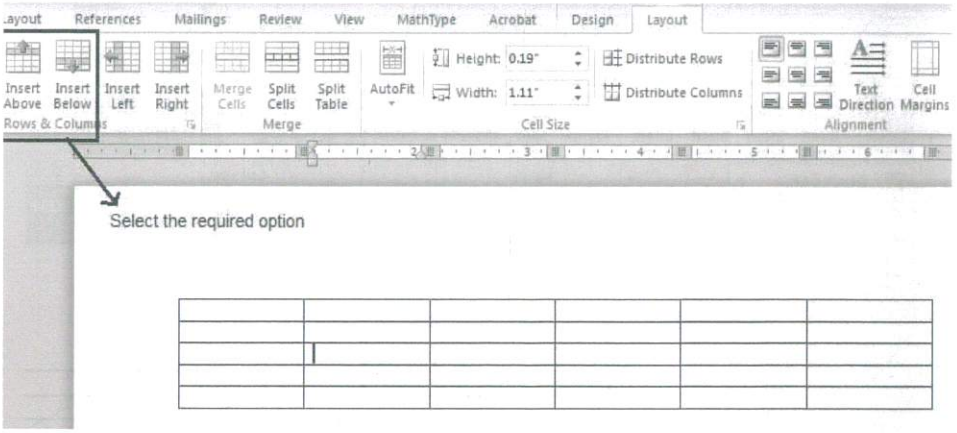
The screenshot of inserting a column on left or right of a selected column in a table is as shown:



Insert Row

- Click on the table. Go to the **Layout** tab.
- In the layout tab, go to the **Rows and Columns** section.
- Click on **Insert Above** or **Insert Below** button for inserting a row above or below the row where the cursor is present.

The screenshot of inserting a row above or below a selected row in a table is as shown:

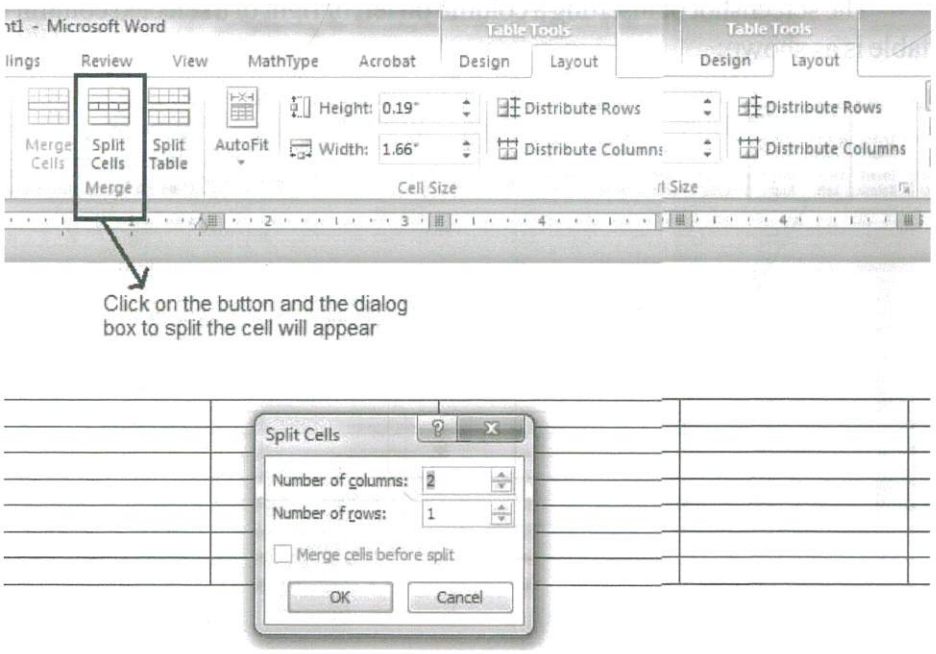


Sections

Section means splitting the cells or table into different parts or sections.

1. Splitting the cells
   - Go to the particular cell in the table. Then, go to the layout menu.
   - Click on **Split Cells** button. **Split cells** dialog box appears that prompts to enter the number of rows and columns.
   - Specify the rows and columns. The cell will be divided into sections.

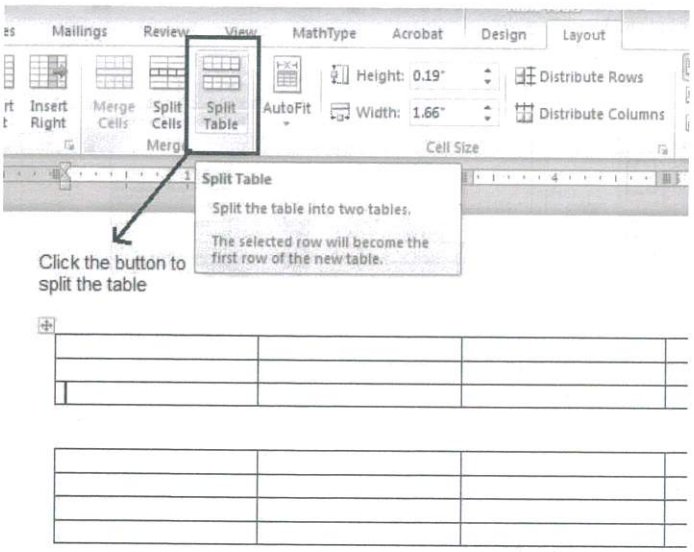
   The screenshot of **Split Cells** is as shown:



2. Splitting the table

- Go to a particular row in the table from where you want to divide the table. Go to the **Layout** bar.
- Click on **Split Table** Button. The table will be divided into sections. The row that was selected will be the first row of the second table of the split tables.

The screenshot of **Split Table** is as shown:



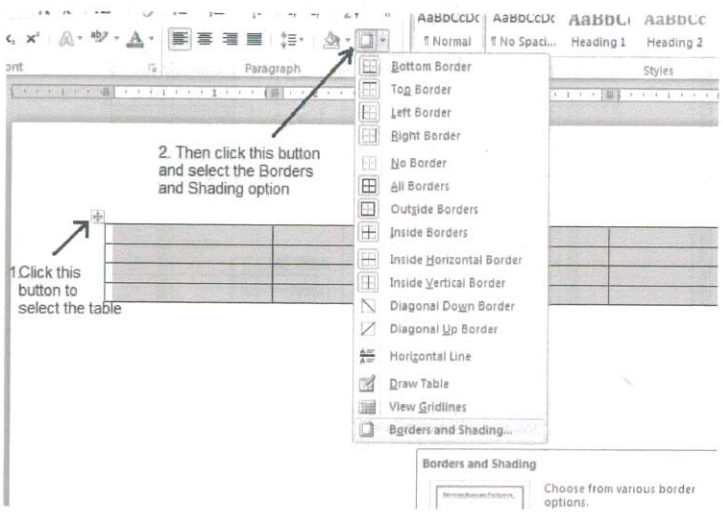
Borders and Shading

With Microsoft, the user can apply border to a table. You can also provide different shades to the table of your choice.

Applying Border to a table

- Select the table to which you want to apply the border.
- Click the **Border** button to select the border from different types of border.
- You can delete the border by selecting **No Border** option.

The screenshot of **Border** option is as shown:

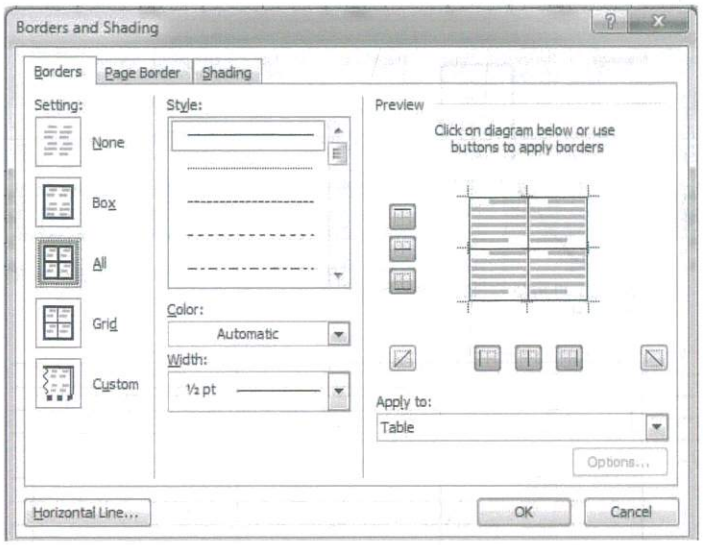


NOTES

Use the 'Border' option

- Select the table. Click the **Border** button, a list will appear. Click on border and shade option.
- A dialog box will appear, select border from that dialog box.
- Choose the border of your choice and color and apply it to the table.

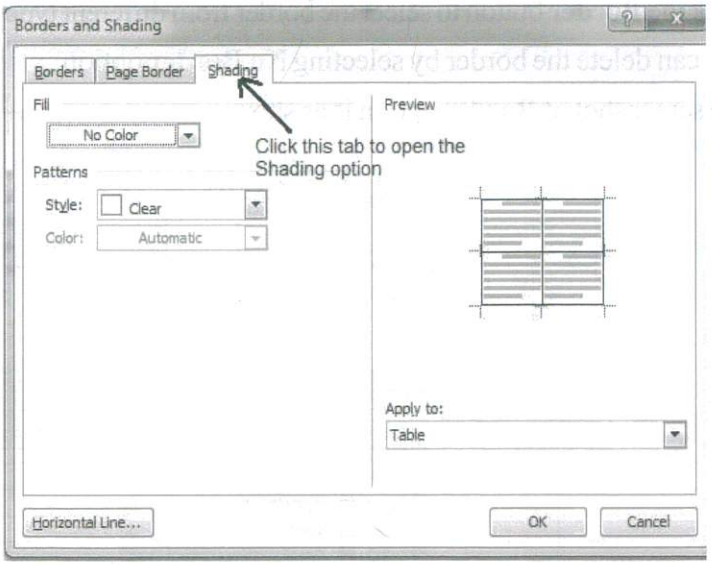
The screenshot of **Borders** options is as shown:



Adding shades to the table

- Select the row or column you want to shade. Go to **Border** button.
- Select **Borders and Shading** option from the list. A dialog box will appear. Select **Shading** tab and select the color of your choice.
- Apply the shade to the row or column. The row or column will get shaded.

The screenshot of **Shading** option is as shown:



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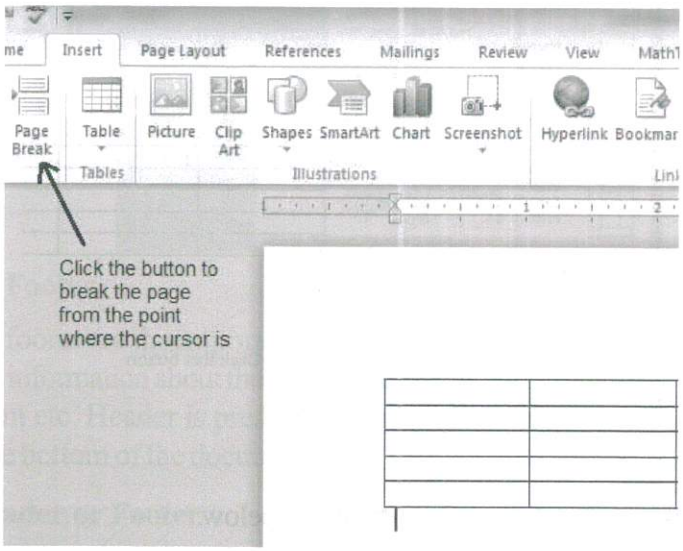
Page Setup and Break

Break: In word, a new page begins after the previous page is completely filled but with the help of break, the user can force the text to start from the new page.

Insert page break

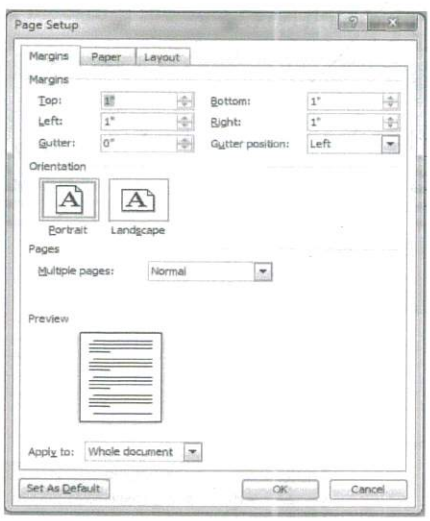
- Open the document. Go to the location from where you want to start a new page.
- Go to the **Insert** tab and click **Page Break**. New page will start from the insertion point.

The screenshot of **Insert page break** is as shown:



Page Setup: This option is present in **Page Layout** tab. It helps in setting the orientation of the page in the document. It also includes options for setting margins on a page and page break. By default, the orientation of a page is selected as Portrait. You can also choose landscape mode. Let's learn about **margin**.

The screenshot of **Page Setup** dialog box is as shown:



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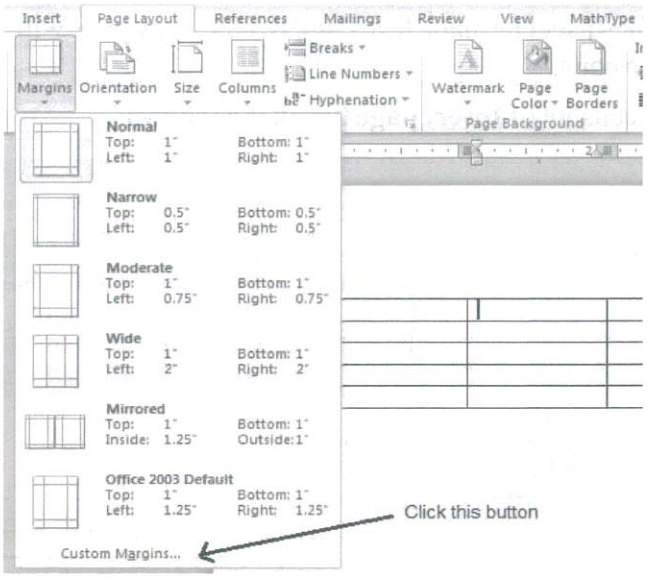
Margin

- Open the document; go to **Page Layout** option and click on **Marginstab**. A listwill appear. Click on **Custom Margin** option available.
- A dialog box will appear that specify the margins you want to keep for the document.

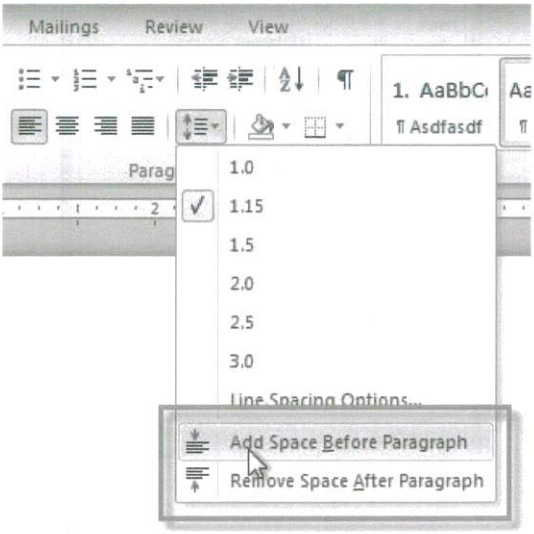
The screenshot of selecting the **Margins** option is as shown:



Line spacing

To format line spacing, follow the steps given below.

1. Select the text in the document.
2. Click the Line and Paragraph Spacing command in the Paragraph group on the Home tab.
3. Select the desired spacing option from the drop-down menu.
4. From the drop-down menu, you can also select Line Spacing Options to open the Paragraph dialog box.



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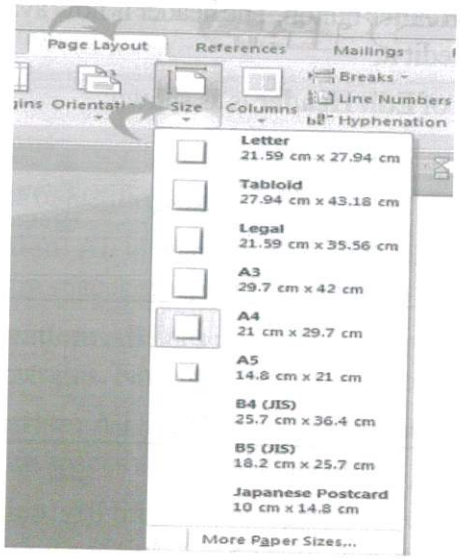
Page length

You can set the page length using the size command of page setup group of page layout menu in the ribbon interface as shown below.



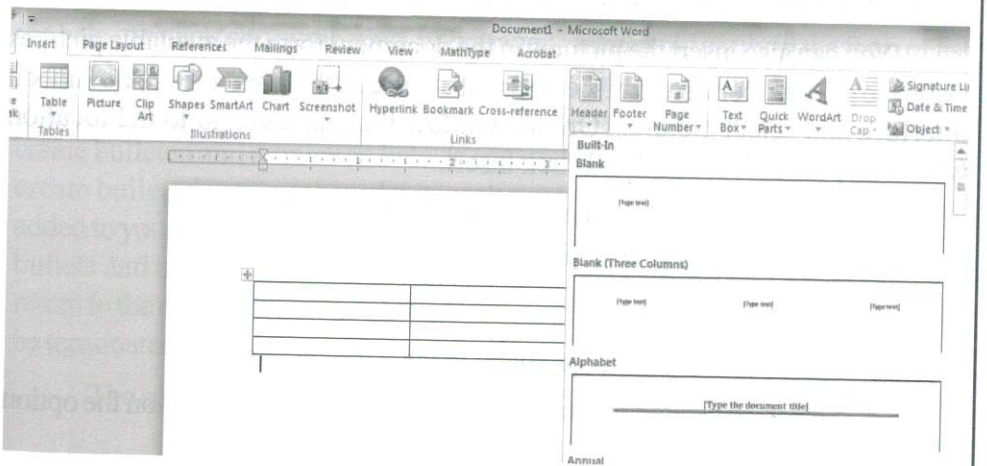
Header or Footer

Header and footer are the important parts of any document. They are used for representing information about the document such as the page number, heading of the document etc. Header is present on the top of the document and footer is present at the bottom of the document.

Adding Header or Footer

- Click on the **Insert** tab. After this, click on either **Header** or **Footer** whichever you want to apply to the document. A list appears from which you can select the header you want to apply to the document.
- When you select the header, it will appear in the editable form in which you can write whatever you want to add.

The screenshot of inserting the header in the document is as shown:



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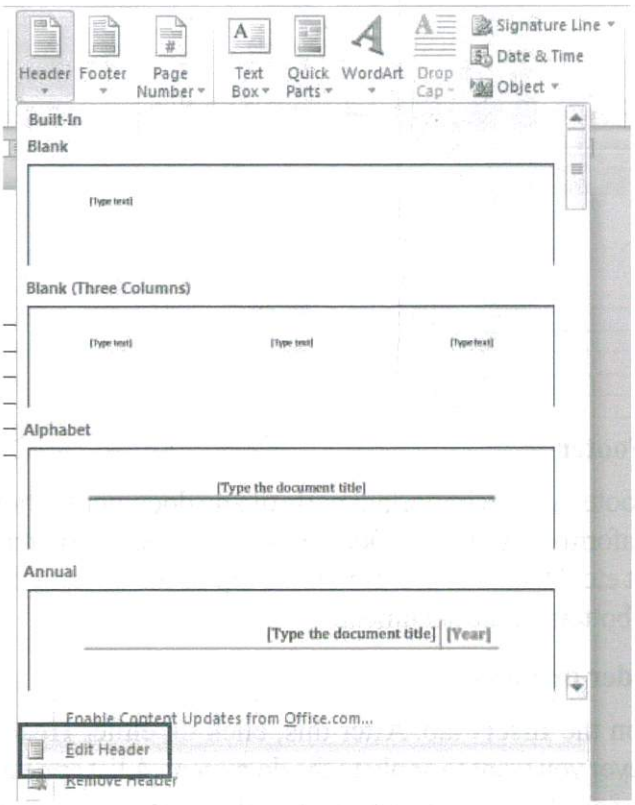
Editing the Header or Footer

- Click on the **Insert** tab. Select header or footer whichever you want to edit. A list will appear with the option **Edit Header**.
- Click the **Edit Header** button. The header is now available in editing form so that you can edit it.

The screenshot of **Edit Header** is as shown:



Inserting special symbols and pictures

You can insert the symbols in a Word document using the symbol command in the insert tab in the ribbon interface. When you click on the symbol command, it shows the various types of symbols which can be selected as per the requirements.

You can also insert the pictures in the document form the available pictures using the pictures command in the insert tab. Click on the Insert tab on the Ribbon interface and select pictures. On the window that appears, go to the location where the picture is located and click Insert.

To wrap text around an image follow the given steps.

1. Select the image. The Format tab will appear.
2. Click the Format tab.
3. Click the Wrap Text command in the Arrange group.
4. Select the desired menu option. The text will adjust based on the option you have selected. ...
5. Move the image around to see how the text wraps for each setting.

Hyphenation Off

To turn off auto hyphenation in Word 2010, follow the steps given below

1. Go to the Page Layout tab > Page Setup group.
2. Click Hyphenation.
3. Select None.

Types of justifications

There are several types of justification:

- **Left-justification**: All lines in the paragraph butt up against the left text margin. No extra spaces are added to the line.
- **Center-justification**: All lines in a paragraph are centred between the left and right text margins. No extra spaces are added to the line.
- **Right-justification:** All lines in a paragraph butt up against the right text margin. No extra spaces are added to the line.
- **Fill-justification.** All lines in a paragraph are expanded so they butt up against both the left and right text margins. Space is added, between words and characters, as necessary to fill out the line.

Cursor movement and control

You can move the cursor to another location by moving the pointer and then clicking, or by using the keyboard. To type anywhere else in the document, you need to move the cursor to that place. Here are a couple of ways to do that:

- With your mouse, move the cursor just to the left of "During," and then click to insert the cursor. Then start typing.
- Press the UP ARROW (↑) on your keyboard to move the cursor up one line at a time. Then press the LEFT ARROW (←) to move the cursor left, one character at a time.

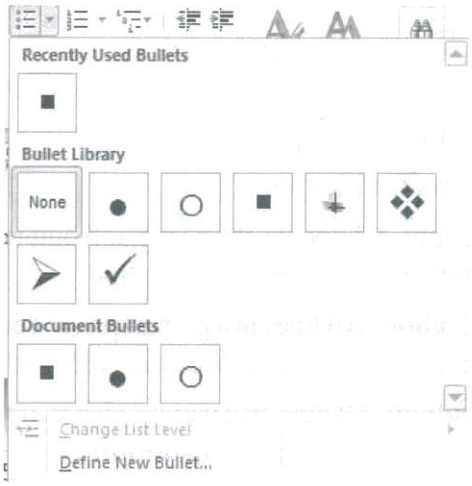
Bullets and Numbering

Bullets and numbering allow you to present information in the simple ways. With the help of bullets and numbering, information is separated easily in the form of list. This helps in saving the space in the document. Bullet and numbering option are available in the paragraph group on the **Home** tab. Microsoft Word lets you to create bulleted and numbered lists, to specify different lines or topics. Once you create bulleted and numbered list, each time you press enter, same bullets are added to your list. If you want to add another bullet, then you can choose different bullets and numbering from the **Home** tab.If you hit enter twice, then you will return to the earlier level. If you hit enter twice at the end of the list, then the list will be terminated.

The screenshot of bullet and numbering list is as shown:

Bulleted list

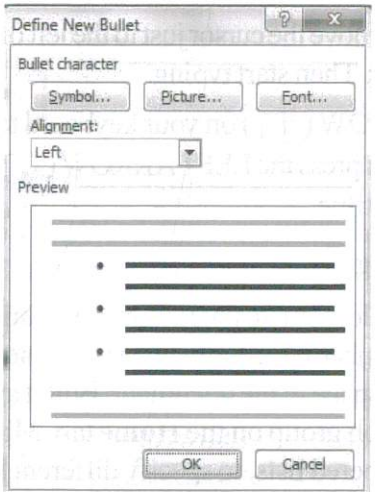
The screenshot of different types of bullets that can be used to create a bulleted list are as shown:



Custom bullet

You can define your own bullet using **Define New Bullet** option. When you click on this option, following dialog box appears. This holds option for setting picture, symbol and font of the bullet character. It also contains the options for alignment and for seeing the preview of the page.

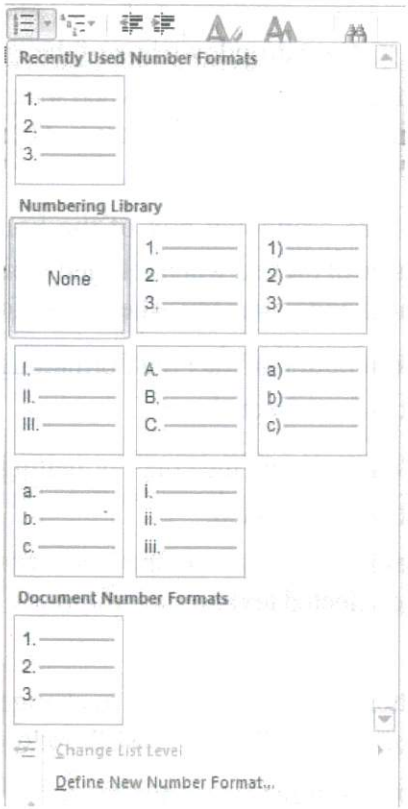
The screenshot of **Define New Bullet** dialog box is as shown:



Numbered list

Numbered list dialog box contains different types of numbered lists like Recently Used Numbered Format, Numbering Library and Document Number Formats.

The screenshot of different types of numbered list is as shown:



Custom Numbering

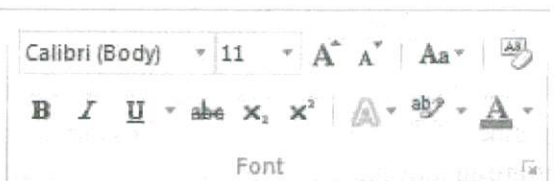
You can define your own numbering using **Define New Number Formats** option. When you click on this option, a dialog box appears containing options for setting number format. It also contains the options for alignment and for seeing the preview of the page.

Font Formatting

Font formatting is used to change the appearance of words or a single character. It is present in the **Home** tab of ribbon view. You can apply the Font formatting by highlighting the text.

Font Formatting contains the various controls for providing a quick access to many frequently used functions.

The screenshot of **Font Formatting** is as shown:



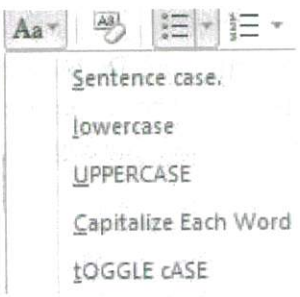
The available **buttons and icons** of the Font Formatting toolbar are as follows:

- Calibri (Body) **Font** dropdown box of the Font Formatting helps in changing the font of text or number when selected. You can choose any font by clicking on the dropdown menu. The default font in Word is Calibri (Body).
- 11 **Font Size** dropdown box of the Font Formatting helps in changing the size of the text when selected. You can choose any size by clicking on the dropdown menu. The default font size in Word is 11.
- A^ **Grow Font** button of the Font Formatting helps in increasing the size of the text when selected.
- A˅ **Shrink Font** button of the Font Formatting helps in decreasing the size of the text when selected.
- **Change Case** dropdown menu of the Font Formatting helps in changing the case of the selected text.

For example:

Suppose you have written "Hello". You want to change the uppercase letter to lowercase, then you can choose **Change Case** dropdown menu to do that.

The screenshot of **Change Case** is as shown:



- **Clear Formatting** menu of the Font formatting helps in clearing the formatting by selecting that particular area. It is useful in situation where you want to remove entire formatting at once.
- **B** **Bold** button of the Font Formatting toolbar helps in making selected text or numbers bold and in removing bold formatting when the text or numbers are already bold.
- *I* **Italics** button of the Font Formatting toolbar helps in making selected text or numbers italics and in removing italics formatting when the text or numbers are already italics.
- U **Underline** dropdown box of the Font Formatting toolbar helps in making selected text or numbers underline and in removing underline

formatting in already underlined text or numbers. You can choose any type of line from Underline dropdown menu.

- **Strikethrough** button draws one straight line throughout the selected word.

For example:

Consider the following sentence "See the effect". If you apply Strikethrough effect by selecting the words then the same sentence will look as shown: "~~See the effect~~".

- **Subscript** button helps in making selected text or character look smaller without changing its Font size. It places them below the other characters.

For example:

Consider the following set of character "a5b." If you apply Subscript effect by selecting number 5, then the following set of character will look as shown: "a_5b."

- **Superscript** button helps in making selected text or character look smaller without changing its Font size. It places them above the other characters.

For example:

Consider the following set of character "a5b." If you apply Superscript effect by selecting number 5, then the following set of characters will look as shown: "a^5b."

- **Text Effects** dropdown menu of the Font Formatting toolbar helps in drawing colored line around the text. You can choose any color from dropdown menu.

For example:

Consider the following sentence "See the effect". If you apply Text Effect by selecting the text then the same sentence will look as shown: **"See the effect"**

- **Highlight** button of the Font Formatting toolbar highlights the text or number with the specified color. By default, "Yellow" color is selected. You can choose any color from the drop down menu. You can add and remove the color by clicking the specific color.

- **Font Color** button of the formatting toolbar helps in changing the color of the text. By default, "Red" color is selected. You can choose any color from the drop down menu.

Page Numbering

For adding Page Numbers to the Header section or Footer section simply click on the Page Number command to select the option Top of Page or Bottom of Page as shown below in the Illustration.

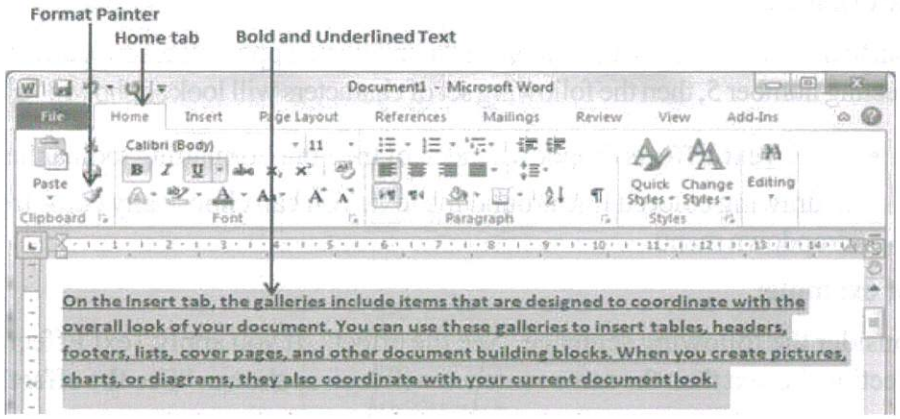
Inserting date and time

You can insert date and time in a document by simply click on date and time command in the insert tab. Follow the steps Insert → Date and Time. After using this you will see date and time in the document.

Format Painter

To use the format painter, use the following steps.

1. Select the text or graphic that has the formatting that you want to copy.
2. On the Home tab, click Format Painter.



3. Use the brush to paint over a selection of text or graphics to apply the formatting. This only works once. To change the format of multiple selections in your document, you must first double-click Format Painter.
4. To stop formatting, press ESC.

2.2.2 Shortcut Keys for Various Tasks

Some of the shortcut keys for various tasks in MS Word are shown in the table below:

Table 5.1 *MS Word Shortcuts*

Using Keyboard Shortcut	
Action	Keystrokes
Creation of new document	CTRL+N
Saving a document	CTRL+S
Opening a document	CTRL+O
Printing a document	CTRL+P

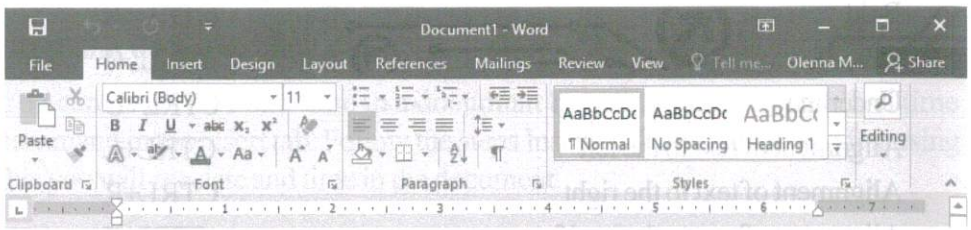
NOTES

Closing a document	CTRL+W
Selecting an entire document	CTRL+A
Copying a text	CTRL+C
Cut specific text	CTRL+X
Paste specific text	CTRL+V
Undo	CTRL+Z
Redo	CTRL+Y
Bold	CTRL+B
Italics	CTRL+I
Underline	CTRL+U
Alignment of text to the left	CTRL+L
Alignment of text to the right	CTRL+R
Alignment of text to the justify	CTRL+J
Alignment of text to the center	CTRL+E
Finding the text	CTRL+F
Replacing the text with particular text	CTRL+H
Adding and removing 6 point of spacing before a paragraph	CTRL+0
Opening font preferences windows	CTRL+D
Inserting link	CTRL+K
Indentation of a paragraph	CTRL+M
Creating an hanging indent	CTRL+T
Creating a bullet point	CTRL+SHIFT+L
Changing the font	CTRL+SHIFT+F
Increasing selected font to 1 point to 12 point	CTRL+SHIFT+>
Increasing selected font to 1 point	CTRL+]
Decreasing selected font to -1 to -12 point	CTRL+SHIFT+<
Decreasing selected font to -1 point	CTRL+[
Viewing or hiding non printing characters	CTRL+SHIFT+*
Moving contents to the beginning	CTRL+'!
Moving contents to the end	CTRL+"!
Deleting Word to the right of the cursor	CTRL+Del
Deleting Word to the left of the cursor	CTRL+Backspace
Moving cursor to the end	CTRL+END
Moving cursor to the beginning	CTRL+HOME
Resetting default font to the highlighted text	CTRL+SPACEBAR
Changing text to heading one	CTRL+ALT+1
Inserting time	SHIFT+ALT+T
Inserting date	SHIFT+ALT+D
To Save As file	F12
Spell Checker	F7
Opening Help	F1

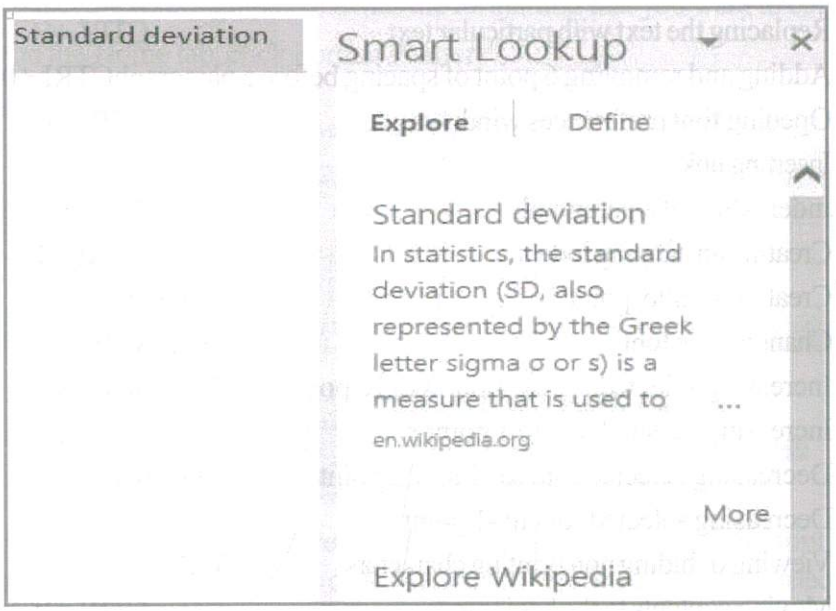
NOTES

2.2.3 New Features in Word 2016/ Difference between Word 2010 and 2016

The **Tell Me** box in Word, Excel and PowerPoint 2016 helps in performing important tasks. Rather than using Help or just poking around as in 2010 version, you can now type what you want to do in this box. Office shows you a list of commands for completing your task. If you have selected something in your document, you will see commands specific to that object.



Insights lets you search for information from within Word, Outlook, Excel, and PowerPoint. Right-click a word or phrase and choose **Smart Lookup**.



If several people are working on a Word document that is stored in OneDrive for Business, **real-time co-authoring,** the feature which was not available Word 2010, allows multiple users to collaborate, edit and update simultaneously. They can see changes as they are made and even where cursors are currently placed.

Word 2016 has the new editing feature of adding and viewing threaded comments, which was missing in Word 2010. There are five view modes in Word 2016 as compared to four in Word 2010. Smart Look Up feature of Word 2016 was missing in Word 2010 and 2013. You can send a link to a document saved on OneDrive, if you are using Word 2016, which was not possible in 2010 version.

Check Your Progress

1. How can the ribbon be minimised?
2. When is the .dotx file format used?
3. When is the ignore option used in MS Word?
4. State the steps used to correct the spelling errors.
5. State the uses of header and footer.

2.3 MS EXCEL 2010

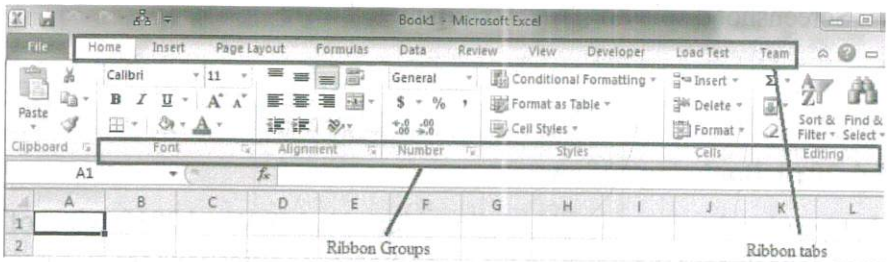
MS Excel: An Overview

Let us analyse the different features of MS Excel.

The Ribbon Interface

Ribbon interface in Microsoft Word 2010 is same as that of Microsoft Excel 2010, the only difference lying with the changes in commands. With the help of ribbon performing various tasks with the spreadsheet becomes easy.

Screenshot for Ribbon is shown as:



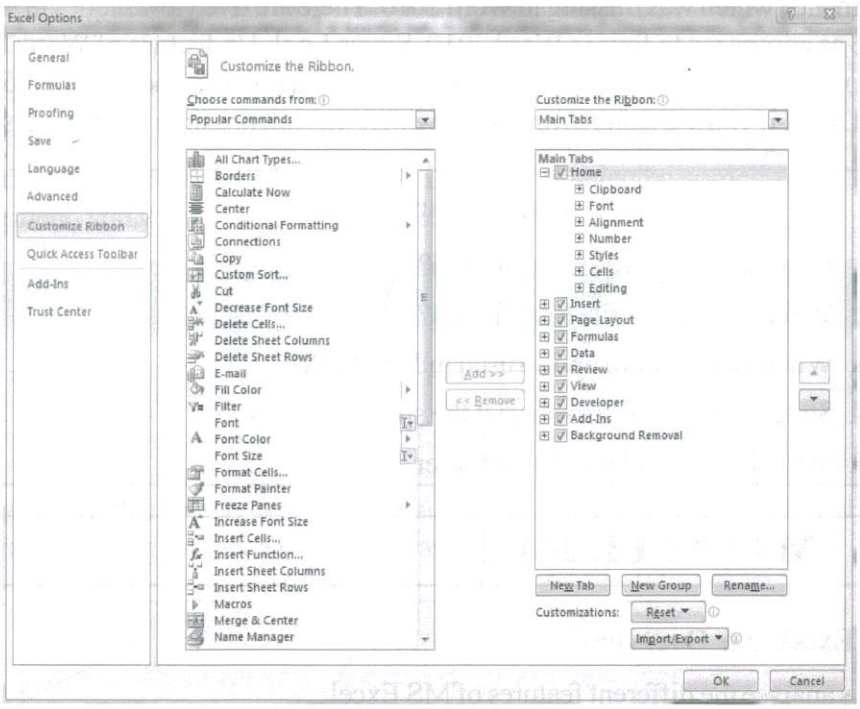
If you click on any tab or groups, each button and dropdown menu will perform different actions

Customizing the Ribbon

Follow these steps to customize the ribbon:

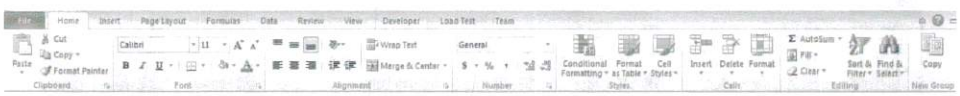
1. Right click on any tab or group and click on the **Customize the Ribbon** option. **Excel Options** dialog box will appear.

Screenshot displaying **Excel Options** is as shown:



2. Choose the command which you want to add. Here, **Copy** command has been selected. Next, click on **New Group** button (in order to add commands the user needs to create a custom group first). Click on **Add** button in order to add selected commands to the **New Group**.
3. Click on **OK** button. **Copy** command will be added to **New Group** which is seen under **Home** Tab after the **Editing** option.

   Screenshot displaying **New Group** is as shown:



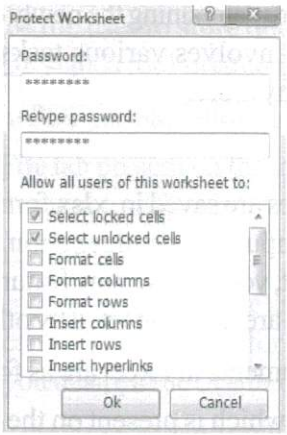
Excel 2010 Backstage View

Backstage view has been previously introduced in MS Word 2010. Most of the features of backstage view remain the same. Some modifications are discussed as follows:

Protect Workbook under Permission tab of Info option includes two more choices. They are:

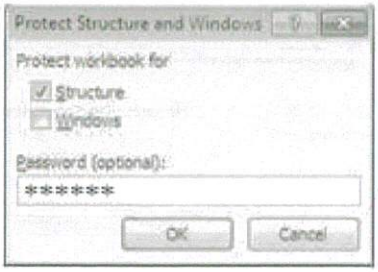
- **Protect Current Sheet:** This option protects current sheet from unauthorized access. Here you set a password for protecting current worksheet. You can also specify which type of changes people can make in this worksheet by checking them on allow all users of this workbook to list.

Snapshot of Protect Worksheet is as shown:



- **Protect Workbook Structure:** By using this option you can protect entire workbook to be changed by unauthorized users. It provides two levels of protection. These are as follows:
  1. **Protect Workbook for Structure:** It protects the structure of the worksheet from unwanted modifications. For example unauthorized users can not add new worksheet or delete an old and cannot change the order of the sheets.
  2. **Protect Workbook for Windows:** It is not checked by default. If you check Windows then the book is protected also from resizing any windows you have inserted in your workbook like charts, pictures, shapes etc.

Screenshot of Protect Structure and Windows is as shown:



As shown, in both the above cases Password is optional.

In order to unprotect, click on Unprotect Worksheet or Unprotect Workbook. You are asked for password, if set.

Creating, Opening and Working with Excel Documents

Microsoft Excel is used for storing the data in the form of table. It is used by several organizations to perform complex calculations, statistical analysis and tracking income and expenses. It uses pie charts, slicers, sparklines to easily analyze the data. Excel 2010 provides very interactive features which help in analyzing and visualizing the data in productive and innovative ways. In this chapter, you will learn about the essential features of MS Excel, various ways of building Worksheets, methods of formatting and filtering data, management of Excel worksheets and various shortcut commands to perform the task easily.

File Management

File management is the task of maintaining the newly created folders or the existing folders in the computer. It involves various tasks such as saving the folder, maintaining the data and many more.

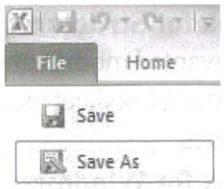
Saving a document

In Microsoft Excel 2010, files are saved in .xlsx format. There are different ways of saving the files in the computer depending upon the requirements. When the files are saved in .xlsx format, you can use new features provided by Excel such as Sparkline and Slicers which are not supported by other file formats.

Steps to save the documents in Excel are as follows:

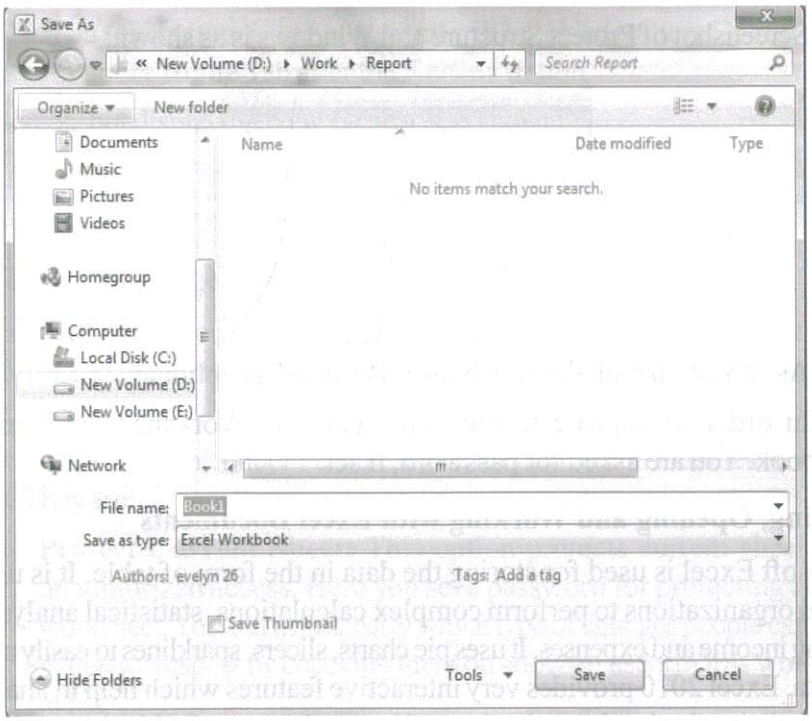
1. Go to the **File** tab which is present on the left hand side of the ribbon.
2. Go to the **Save As** options on the left most side of the screen.

The screenshot of **Save As** option is as shown:



3. Choose the drive and folder where you want to save the file.

The screenshot displaying specific **Drive and Folder** is as shown:



4. Go to the **File name** textbox to write the name of the file.
5. Choose the format in which you want to save the File. By default, the file format is .xlsx.
6. Click the **Save** button to save the file.

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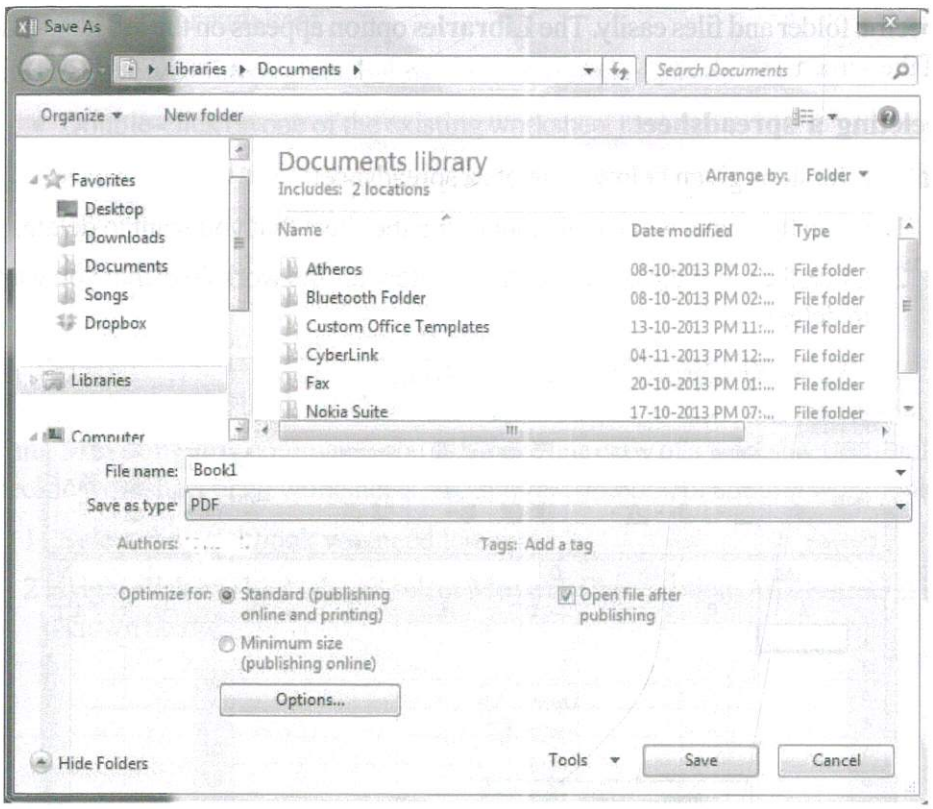
Saving a Document as PDF

Excel 2010 provides enables the user to store documents as PDF files, while sharing them with others. PDF stands for Portable Document Format.

To save an Excel file in PDF format follow these steps:

- First click on the **File** tab present on the top left corner of MS Excel or press Alt+F as a shortcut to **File** tab.
- After this click on **Save As** option.
- Now, enter the filename. When you are asked to select the type of file, choose **PDF.** You can select **Standard** for high quality printing or select **Minimum size** if you desire a file of small size.

Screenshot displaying the **Save as type** option is as follows:



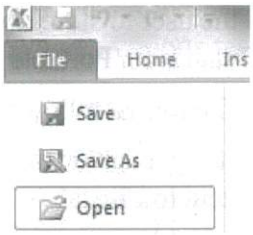
- Finally, click on **Save** button to save file in PDF format.

Opening a document

Steps to open the document are as below:

1. Go to the **File** tab which is present on the left hand side of the ribbon.
2. Go to the **Open** option on the left most side of the screen.

The screenshot showing **Save As** option is as shown:



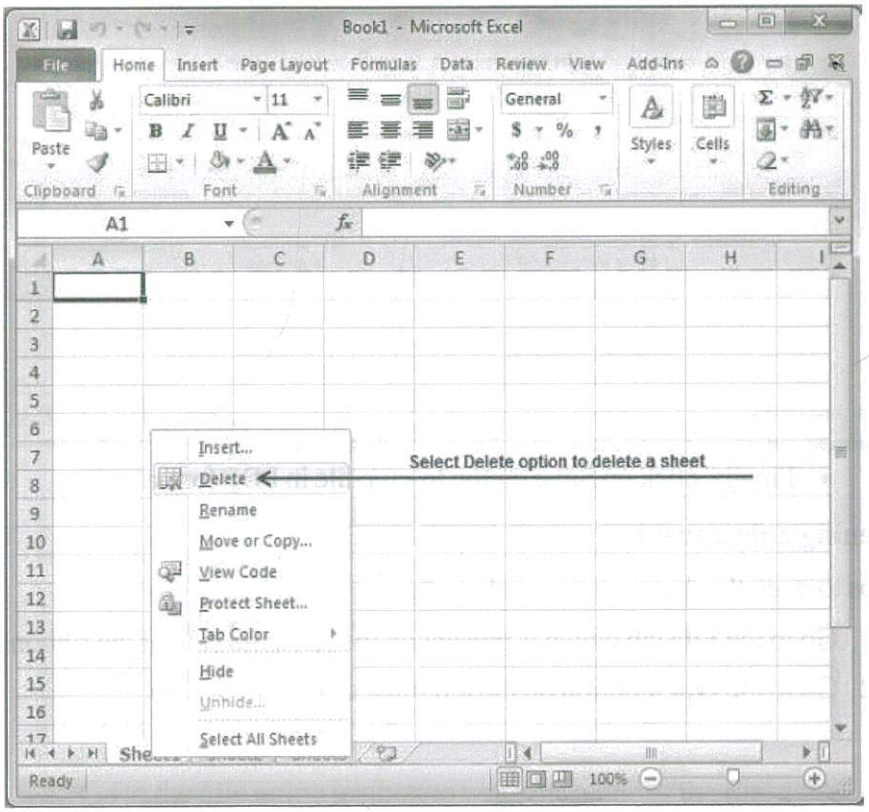
3. Choose the appropriate drive and folder from where you want to open the file.
4. Choose the file which you want to open.
5. Go to the **Open** option to open the file.

You can save the important files in the **Libraries** so that you can access the specific folder and files easily. The **Libraries** option appears on the left hand side of the screen.

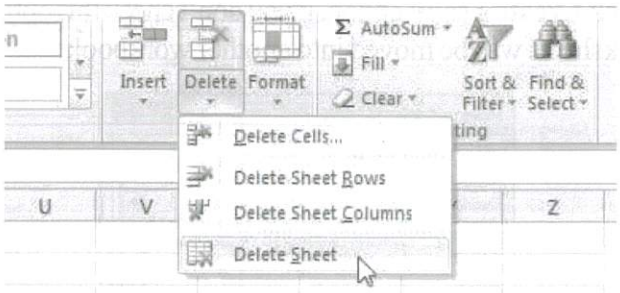
Deleting a spreadsheet

Follow the steps given below to delete a spreadsheet.

1. Open the Excel workbook containing the sheet that you want to delete.
2. Click the tab at the bottom of the window for the worksheet that you want to delete.



3. Click the **Home** tab at the top of the window.
4. Click the arrow under the **Delete** button in the **Cells** section of the ribbon at the top of the window, then click the **Delete Sheet** button.



5. Click the **Delete** button to confirm that you want to delete the sheet.

Reordering spreadsheets

You can change the order of sheets as per your need in a file by simply click, hold and drag on the sheet tab at the bottom of the window.

Renaming a spreadsheet

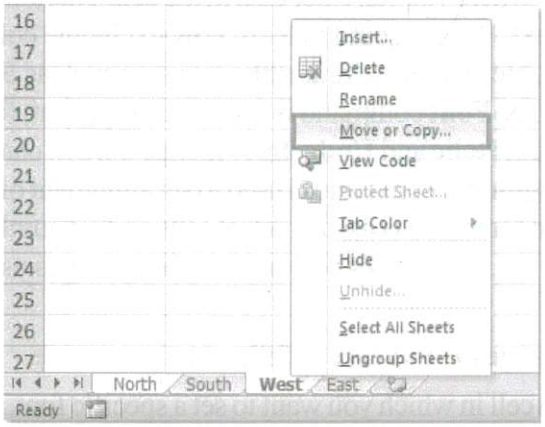
You can follow the steps given below to rename a spreadsheet:

- Double-click on one of the existing worksheet names.
- Right-click on an existing worksheet name, then choose Rename from the resulting Context menu.
- Select the worksheet you want to rename (click on the worksheet tab) and then select the Sheet option from the Format menu. This displays a submenu from which you should select the Rename option.

Duplicating/Copying sheets in a workbook

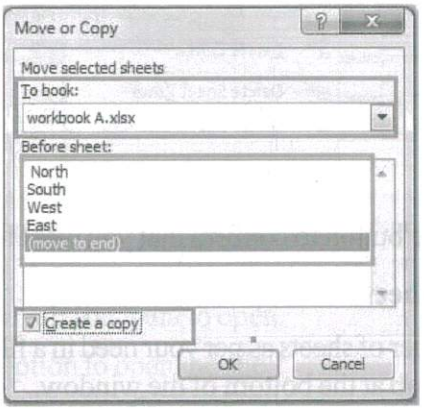
Using **Move or Copy** command, you can make one copy of a worksheet, multiple specific worksheet or all worksheets into active workbook or another workbook.

1. Select the workbook you need to copy.
2. Right click on sheet tab and select **Move or Copy** option. An illustration is shown below.

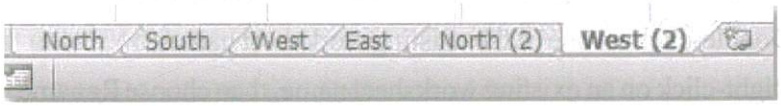


3. In the **Move or Copy** dialog box, specify the following settings.
   - From **To book**, you can specify the workbook where the worksheets will be copied into.
   - Specify the position of the copied sheets, you can choose it after all of the existing sheets.

- Check **Create a copy** option, if you don't check this option, the selected worksheets will be moved into another workbook.



4. And then click **OK**, it will copy the selected worksheets one time into the specified workbook. The screenshot is given below.



2.3.1 Working with Cells

Excel file is a workbook that contains one or more worksheets. Formatting Excel sheet improves the presentation of the worksheet and makes it easy to use. By default, each Excel file has three worksheets.

Entering data and Text formatting

To insert data in the spreadsheet, you can select the row or column where you want to insert the data or insert new rows and column in between.

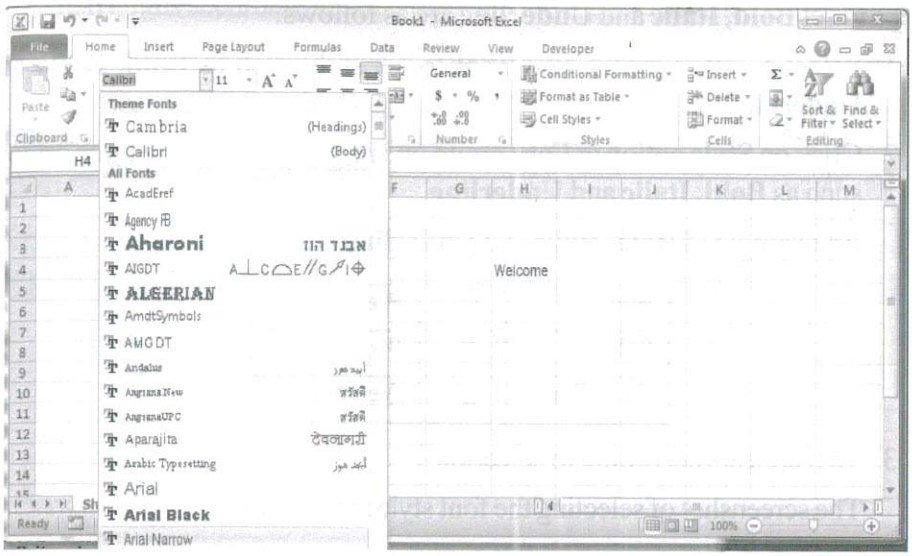
Formatting Cells

Microsoft Excel has 16,384 columns and 1,048,576 rows. Cell is intersection of rows and columns where you can enter data in the cell. There are many options to format cell and text. We are going to learn how to change colour, style of cell, alignment of text, etc. There are four ribbon groups such as **Font**, **Alignment**, **Number and Styles**. **Font** command is used to change font, font size, and style of text such as **Bold**, **Italic** and **Underline**, change border, change the cell color and text color. **Alignment** command is used to set alignment of text and merging the cells. **Number** command is used to select cells and set number format such as percentage, date, etc. **Cell styles** option in **Styles** group is used to set specific color to cell.

Steps to change the **Font** are as follows:

1. Select a cell in which you want to set a specific font.
2. Click on **Font** option from the **Font** on **Home** tab.
3. Select the desired font from drop down list to apply the font.

The screenshot of selecting the **Font** is as shown:



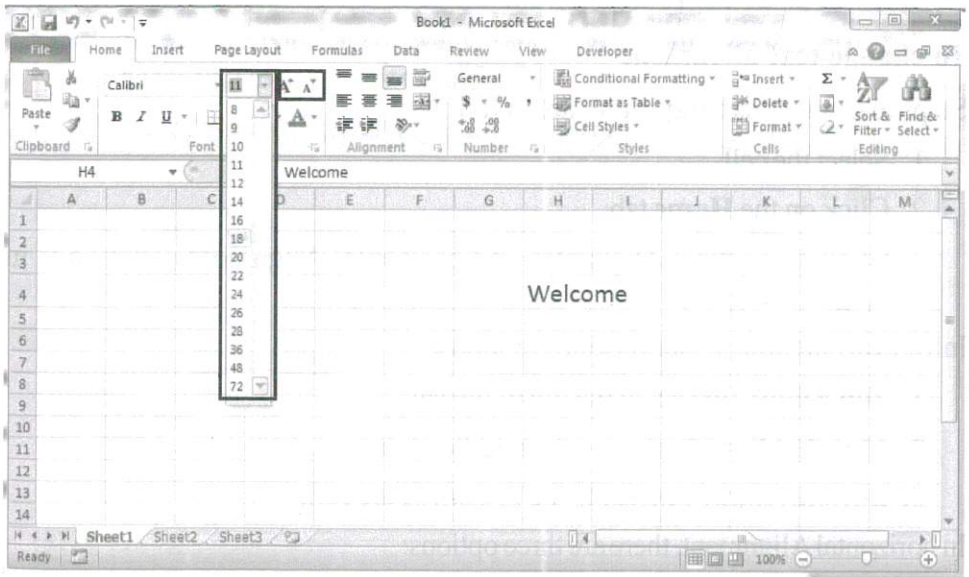
To change a font size

Steps to change a **font size** are as follows:

1. Select a cell in which you want to set specific font size.
2. Click on **Font Size** from the **Font** on **Home** tab. There are two options for increasing and decreasing fonts.
3. Select font size from drop down list. Otherwise, click on increasing font or decreasing font.

If you click on increasing font option, text size increases according to the selection. If you click on decreasing font option, text size decreases according to the selection.

The screenshot of selecting the **Font Size** is as shown:



To set Bold, Italic and Underline option

Steps to set **Bold**, **Italic** and **Underline** are as follows:

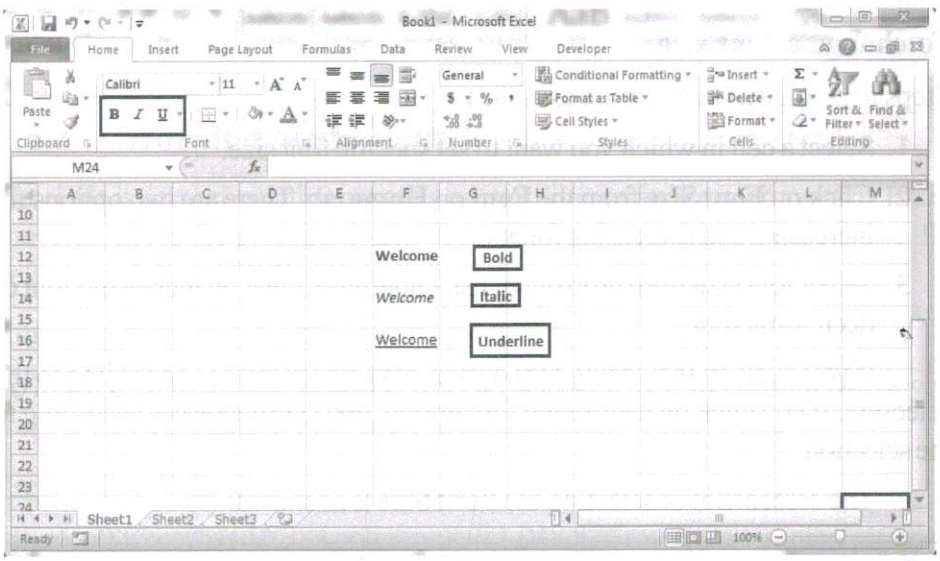
1. Select a cell in which you want to set style such as **Bold**, **Italic** and **Underline**.
2. Click on **Style** option in **Font** group on **Home** tab. There are three options such as **Bold**, **Italic** and **Underline**.

   An example of **Bold**, **Italic** and **Underline** is as shown:

Bold	**B**	**Welcome**
Italic	*I*	*Welcome*
Underline	U	Welcome

3. Text appears according to selection.

   The screenshot of selecting the font style is as shown:



To change text alignment

Steps to change **text alignment** are as follows:

1. Select the cell.
2. Click on the **Home** tab.
3. Click on vertical Alignment and horizontal Alignment commands in **Alignment** group.

In vertical Alignment, there are three options:

1. **Top Align:** Text set to the top of the cell.
2. **Middle Align:** Text set to the middle of the cell.
3. **Bottom Align:** Text set to the bottom of the cell.

In horizontal Alignment, there are three options:

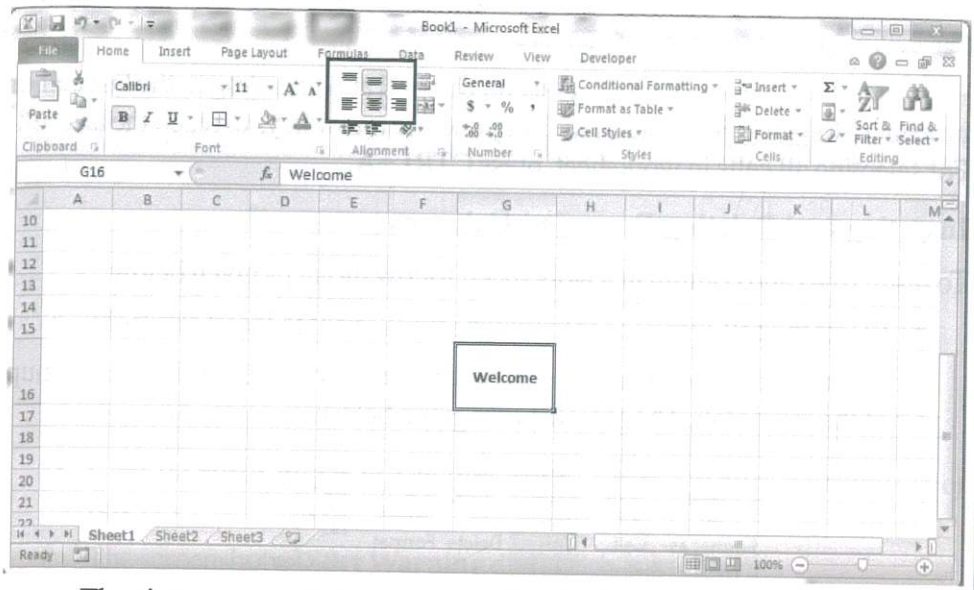
- **Align Text Left:** Text set to the left of the cell.
- **Center:** Text set to the center of the cell.

NOTES

- **Align Text Right:** Text set to the right of the cell.

  Text aligns according to the selection.

  The screenshot of selecting the **Alignments** is as shown:



The given screenshot shows vertically Middle Align and horizontally Center alignment.

Applying cell styles

Cell styles contain the formatting of font and cell. You can directly use cell styles to set the range of cells. Excel 2010 has in-built cell styles that you can use. You can also create your own cell style.

Steps to apply **cell style** are as follows:

1. Select the cell.
2. Click on cell styles in **Styles** group on **Home** tab.
3. Select cell style that you want to apply on the cell. Cell is now displayed according to the style selected.

The screenshot of the **cell style** is as shown:

Selecting Cells or Range

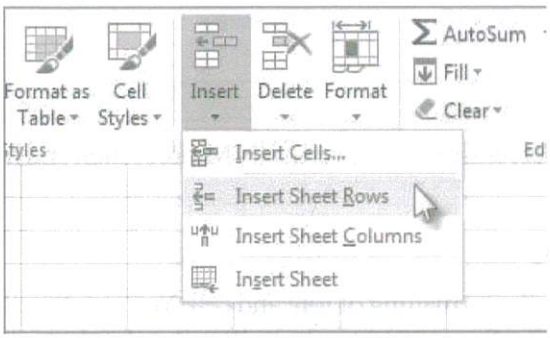
When you edit sheets in MS Excel 2010, you often need to select cells, copy cells, set a range for deleting cells, and also search for data within the cells of a worksheet. To select a particular cell, select that cell or use arrow keys to reach that cell.

For the selection of range, click on first cell and then drag to the last cell or instead of dragging, just hold SHIFT key and use arrow keys to reach the last cell. For selecting all cells in worksheet, press CTRL+A.

Inserting and Deleting Rows and Columns

To insert rows and column in a worksheet, follow the steps given below.

1. Select the cell or row or column where you want to insert row/column.
2. Click the drop-down arrow attached to the Insert button in the Cells group of the Home tab. The screenshot is given below.



3. Select the one of the option in the drop down menu as per requirement.

Sorting and Filtering Information

In MS Excel, you can store enormous data. If you want to arrange the data, you can use **Sort** command. **Filter** command is used to find any specific information from specific column. In Excel 2010, **Sort** and **filter** command are available together in **Editing** group on **Home** tab. Both the commands are described in further subsections.

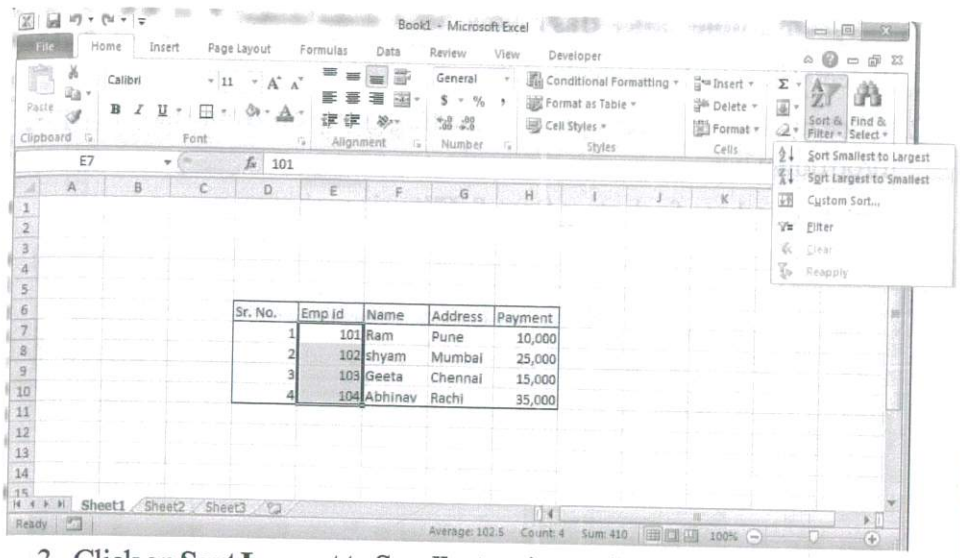
Sort: Sort is most commonly used command to arrange the list of data in alphabetical order. In Excel, there are two basic sorting methods such as A to Z and Z to A. For example, if you want to arrange employee name in ascending order, click on A to Z in **Sort & Filter** option. Sort command is used to visualize the data such that it increases understanding and makes data easily searchable.

Sort Data in single column

Steps to **Sort Data** in single column are as follows:

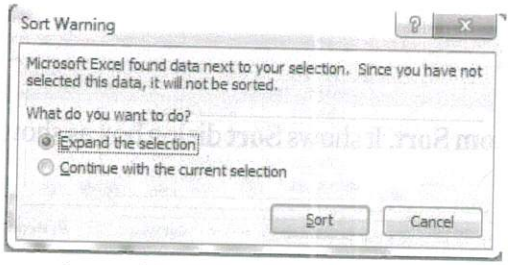
1. Select a column in which data needs to be sorted.
2. Click on **Sort & Filter** option in **Editing** group on **Home** tab. It displays drop down list.

The screenshot of selecting **Sort & filter** is as shown:



3. Click on **Sort Largest to Smallest** option. It displays **Sort Warning** dialog box.

The screenshot of **Sort Warning** dialog box is as shown:

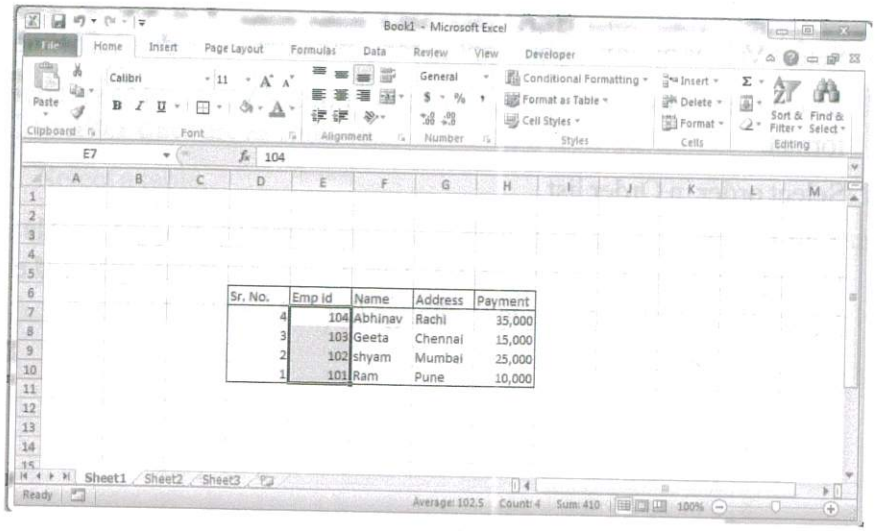


There are two options which are as follows:

- **Expand the selection:** Sort selected column with other columns data.
- **Continue with the current selection:** Sort only selected single column.

4. Click on **Expand the selection**.
5. Click on **Sort** button.

The screenshot of selecting **Sort** button is as shown:



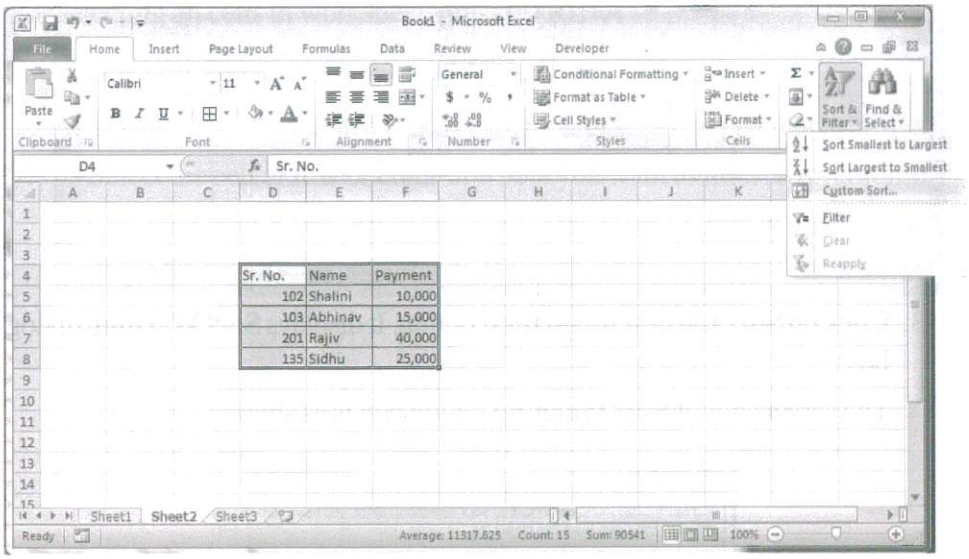
NOTES

To Sort multiple data

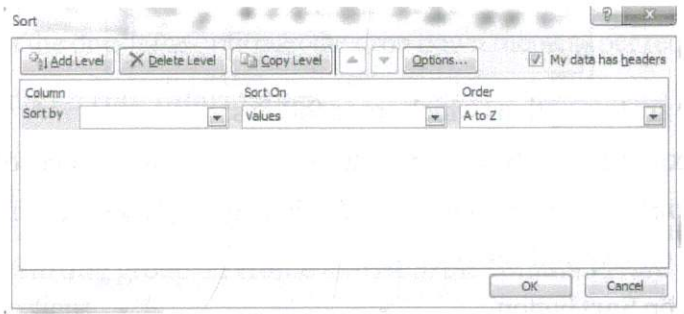
Steps to **Sort multiple data** are as follows:

1. Select whole table in Excel sheet.
2. Click on **Sort & Filter** option in **Editing** group on **Home** tab. It displays drop down list.

   The screenshot of selecting **Sort & Filter** is as shown:

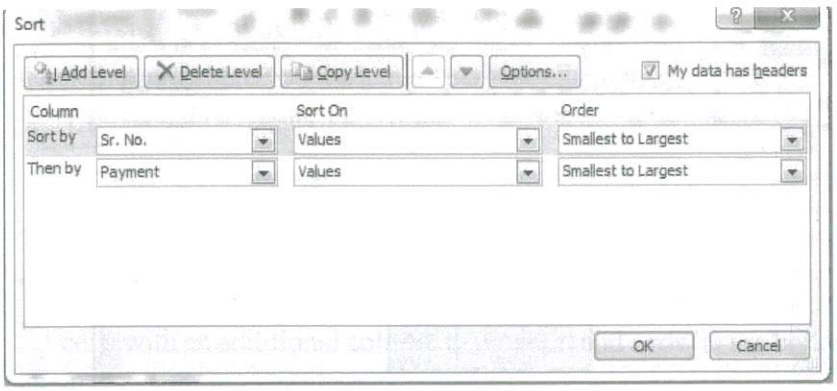


3. Click on **Custom Sort**. It shows **Sort** dialog box as shown in the screenshot:

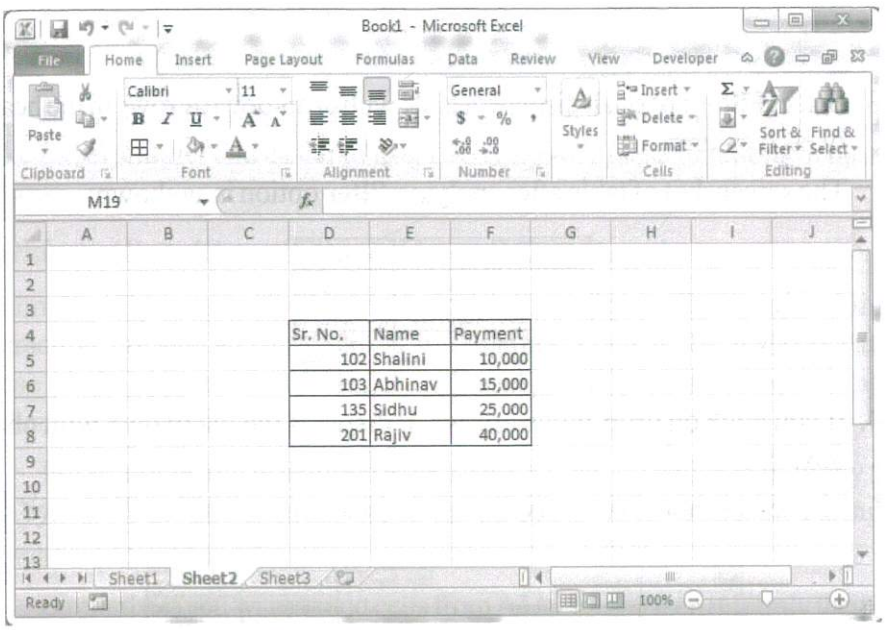


4. Select the column that you want to sort in **Sort by** drop-down box.
5. Select type of sort in Sort On list.
6. Select Values option if you want to sort text, number or date and time.
7. Select Cell color, Font color, Cell icon option if you want to sort data by format.
8. Select order in Order list.
9. **Add Level** is used to add another column to sort by. **Copy Level** is used to copy a column to sort by. **Delete Level** is used to delete selected entry. Up or down arrows are used to change the order of the **Column**.

The screenshot displaying the options in **Sort** dialog box is as shown:



10. Click **OK** button. It displays a table which is as shown in the screenshot:



Filter

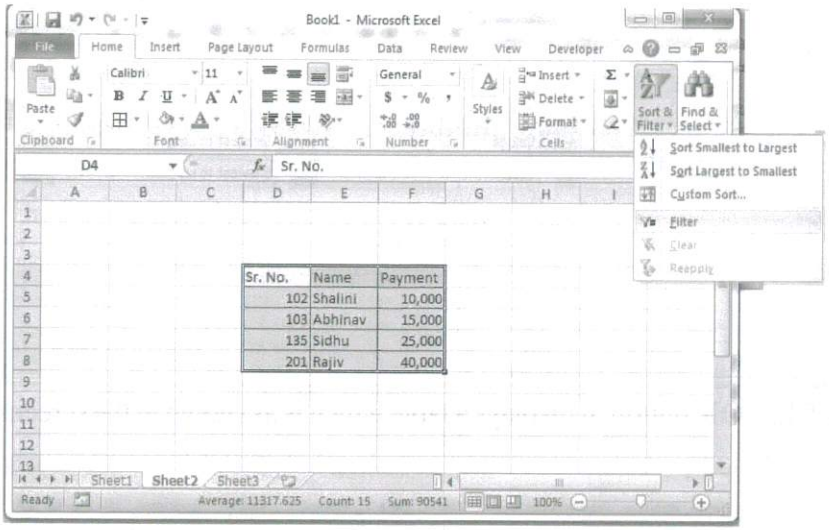
You can find any value, information quickly in worksheet using **Filter** command. You can filter more than one column of data. **Filter** command creates a list of data. Therefore, you can see any information from a list. Let's learn how to use filter command.

To filter data

Steps to **filter data** are as follows:

1. Select a table.
2. Click on **Sort & Filter** option in **Editing** group on **Home** tab. It displays the drop-down list.

The screenshot of selecting **Sort & Filter** is as shown:



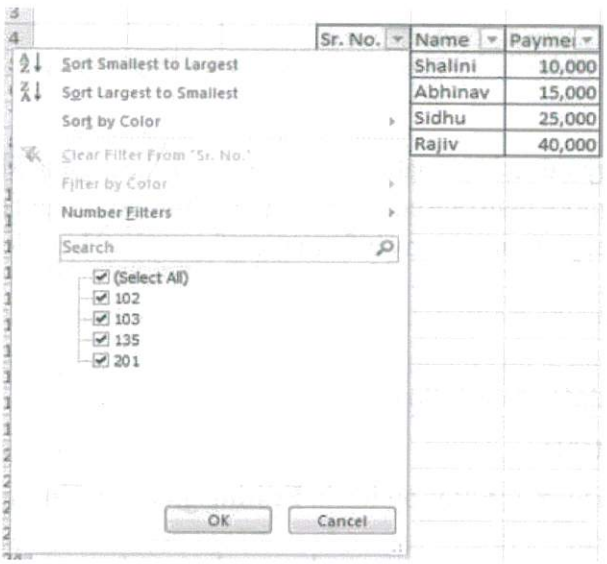
3. Select **Filter** option. It displays a table with drop-down arrows in the header of each column.

   The screenshot of table after applying **filter** option is as shown:

Sr. No.	Name	Payme
102	Shalini	10,000
103	Abhinav	15,000
135	Sidhu	25,000
201	Rajiv	40,000

4. If you click on drop-down arrows, it displays the list of data with check box.

   The screenshot of table displaying drop-down arrows is as shown:



When you uncheck any check box of data, that data will not be displayed in the table.

NOTES

AutoSum in spreadsheet

Follow the given steps to apply AutoSum

1. Click the cell where you want to display the calculation.
   - To sum with a range of numbers, select the range of cells you want.
   - To sum with only some of the numbers in a range, select the cells or range you want using the Ctrl key. Excel inserts the sum in the first empty cell below the selected range.
   - To sum both across and down a table of number, select the range of cells with an additional column to the right and a row at the bottom.
2. Click the Formulas tab.
3. Click the AutoSum button.

2.3.2 Working with Basic Formulae and Charts

There are various formulas and functions available in Microsoft Excel 2010, which make Excel simpler and easier to use. Let us explore these functions in the next sections.

Working with Arithmetic Operators and Text Functions

Arithmetic Operators involve four major operations. These are: addition, subtraction, division and multiplication. These are known as the **basic operators**. These basic operators can be combined so as to perform more complex mathematical operations.

For example, if it is required to add cells A1 and A2 and then multiply their sum by a third cell (A3), then in Excel, this operation can be performed using the formula: = (A1 + A2)× A3

Similarly, if you want to add cells from A1 to A5 and then multiply their sum by a third cell (A6), then, write the formula as: =SUM (A1:A5) × A6

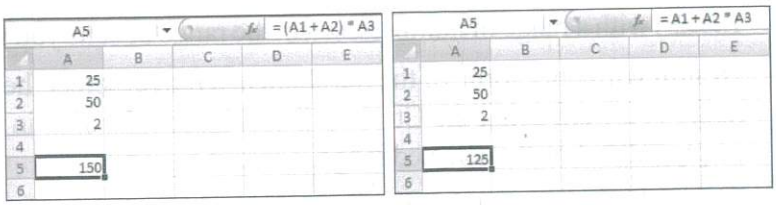
This formula adds numbers in the cell from A1 to A5 and the answer obtained is multiplied by number in cell A6. The answer is displayed in the cell where formula is written. While performing more complex operations on an arithmetic operator, operator precedence plays a very important role. Excel follows the BODMAS (Bracket Order Division Multiplication Addition Subtraction) rule of order of execution in arithmetic operations. The order precedence will be clear with the help of following example:

1. Open a new Excel sheet. In cell A1, enter 25. In cell A2, enter 50 and in cell A3, enter 2.
2. Click in cell A5 and enter the formula = (A1 + A2) × A3 and hit enter. The answer displayed in A5 is 150.
3. Now, enter the formula = A1 + A2 × A3 and hit enter. The answer displayed in A5 is 125. Clicking on cell means that the result will be shown in this cell.

NOTES

In this example, the bracket is solved first where addition takes place. Thereafter, the result is multiplied by third number outside bracket.

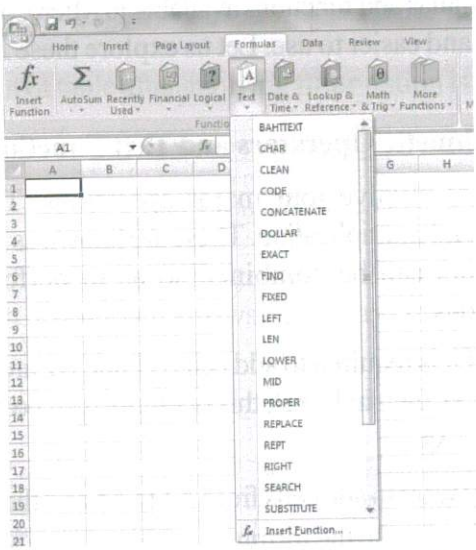
The screenshot representing the discussed example is as shown:



Text Functions

Text functions, which are the part of **Function Library** group, are available at the **Formulas** tab. Some of the functions available under **Text** functions are CHAR, CONCATENATE, REPLACE, LOWER, UPPER, DOLLAR, TEXT, etc.

The screenshot of **Text** functions is as shown:



Some of the commonly used **text** functions are explained as follows:

- **CONCATENATE Function**

This function is used to combine or merge two values. Suppose, you have two columns and you want to combine both of them, then this function is used.

The syntax of **CONCATENATE** function is—**CONCATENATE (Text1, Text2, ...)**

Where, **Text1** represents first text string and **Text2** represents text string for concatenation with the previous text string. The text strings must be separated by commas.

For example, if the excel has "first name" of a person in it as the first column and the other column contains the "last name" then, to combine both the first and last name in a single column, CONCATENATE function can be used.

Use the CONCATENATE function as—**CONCATENATE ("John", " ", Smith")**. Thus, on applying this function the output will be the full name of the person like—John Smith

NOTES

- **REPLACE Function**

REPLACE function is used to remove the sequence of unwanted characters from the Excel sheet with another set of characters. These unwanted characters appear in the cell whenever the data is copied from one Excel sheet to another.

The syntax of **REPLACE** function is: **REPLACE (Old_text, Start_num, Num_chars, New_text).**

Old_text represents the original string of characters required to be replaced.

Start_num identifies the position from where the substitution of the characters starts. **Num_chars** denotes the number of characters to be replaced in the old_text.

New_text is the set of characters that will be used for replacement.

To access the REPLACE Function, go to the **Text** function drop-down menu, navigate to the **REPLACE** function and click on it. Also, enter the data in the respective fields of **Function Arguments** dialog box of the **REPLACE** function.

For example: Enter the original string as **"ab123"**(as string must always be enclosed in double inverted commas) in the **Old_text** and enter numeric value **2** in the **Start_num** field. In **Num_chars** field, enter the value as **4** . At last, in the **New_text** field, enter **cde** as the the string which will be used for substitution.

After filling the data, when you click on the **OK** button, the final result or output of the **REPLACE** function will be obtained as:

acde

- **UPPER, PROPER and LOWER Function**

In Microsoft Excel, some functions are available for converting the entered data into uppercase, proper case and lowercase. If you want to make all the characters of a string uppercase, then enter the command = **UPPER (Place of string)**. In the similar way, the functions **LOWER** and **PROPER** are used.

Thus, if you enter the name as **William** and apply Upper function on it as— **UPPER (William)**, then the result obtained or displayed will be **WILLIAM**.

Similarly, if the name entered in the Excel sheet column is **RICKY PONTING** and **LOWER** function is applied on it as— **LOWER (RICKY PONTING)**, then the result obtained or displayed is **ricky ponting**.

And, in case you apply PROPER function with syntax as— **PROPER (RIcKy PoNting)**, then you will get the output — **Ricky Ponting**.

- **TEXT Function**

The **TEXT** function helps in converting a numeral value or number to text in a required number format. This function is helpful when you want to display numbers in a more readable format. It also helps in combining numbers with text or symbol and in displaying the number as a text containing several places of decimal digits.

The syntax of **TEXT** function is

—**TEXT (Value, Format_ text)** where, **Value** represents a numeric value or is a reference to a cell containing a numeral or numeric value. **Format_ text**

represents a field for entering the text string to be converted into a numeric value.

To access the **TEXT** Function, go to the **Text** function drop-down menu, navigate to the **TEXT** function and click on it. Now, enter the data in the two fields under the **Function Arguments** dialog box of the specific function.

For example, enter the number **143** as the **Value** and **" 0.0000"** as the **Format_text** field to convert the number in the decimal format. After filling the data apply the **Text** function as— **TEXT (143, "0.0000"0)**. When you click on OK, then the final result of the **TEXT** function i.e. after converting a numeric value to a text containing 4 decimal digits, will be displayed in the Excel sheet as:

143.0000

- **Summing up Text Functions:**

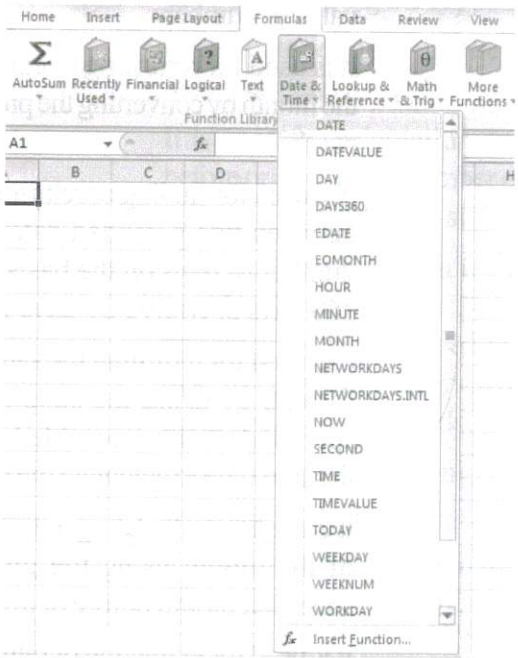
Function	Description
BAHTTEXT	It is used for transforming or converting a number to a text using the currency format BAHT.
CHAR	It is used for providing the character of the specified code number or value.
CLEAN	It is used for clearing out all those characters from the text that are non-pritable and will not be printed with the operating system.
CODE	It is used for extracting the first character from the text string and returning the numeric code for that.
DOLLAR	It is used for converting a numeric value to text using the $ currency format.
EXACT	It is used for finding or comparing two text values.
FIND	It is used for locating the position of one text or substring within another text or string.
FIXED	It is used for rounding off the number and fixing the number of decimal places.
LEFT	It is applied to the text value for returning the leftmost characters from it.
LEN	It is used for calculating the value of the length of the string.
MID	It is used for returning the number of required characters using the provided position, from the text string.
REPT	It is used for repeating the text as per the number of times mentioned or given
RIGHT	It is applied on a text value for returning the rightmost characters from it.

SEARCH	It is used for searching or locating the required value or text within another value or text
SUBSTITUTE	It is used for replacing the old text with new or current text.
T	It is used for checking whether the passed value is text or not. If the value is text then it returns that and if it is not then double quotes are returned.
TRIM	It is used for replacing and trimming out the extra spaces present in the text, leaving behind only single spaces between words
VALUE	It is used for converting the argument or value passed as number to text.

Date and Time Functions

Date & Time functions are used for making the modifications in date and time and also, to know the current date and time. There are various **Date & Time** functions which are collectively present or available in the MS Excel under **Date & Time** icon of the **Formula** tab.

The screenshot of **Date & Time** functions is as shown:



The **Date & Time** functions are explained as follows:

- **DATE Function**

The **DATE** function is used to represent the specific date. The syntax of **DATE** function is

"=DATE (Year, Month, Day)". This function can be accessed from the **Date & Time** drop-down menu of **Function Library** group under **Formulas** tab.

For Example: In the **Function Arguments** dialog box of **DATE** function if you enter valid entries for **Year**, **Month** and **Day** for the respective fields, then the **DATE** function will be applied as: **=DATE(2013,10,2)** and you will get the output as **10/2/2013**.

- **TIME Function**

The **TIME** function returns the time in TIME format (Hour, Minute and Second). The syntax of **TIME** function is ——**TIME (Hour, Minute, Second)**.

This function is also accessed from the **Date & Time** drop-down menu of **Function Library** group of **Formulas** tab.

For Example: In the **Function Arguments** dialog box of the **TIME** function, if you fill the valid entries of **Hour**, **Minute** and **Second** in the corresponding fields and use the **TIME** function on the entered data as— **TIME (12,34,78)**, then the output in the cell will be shown as **12:35PM**.

- **Summing up Date & Time Functions**

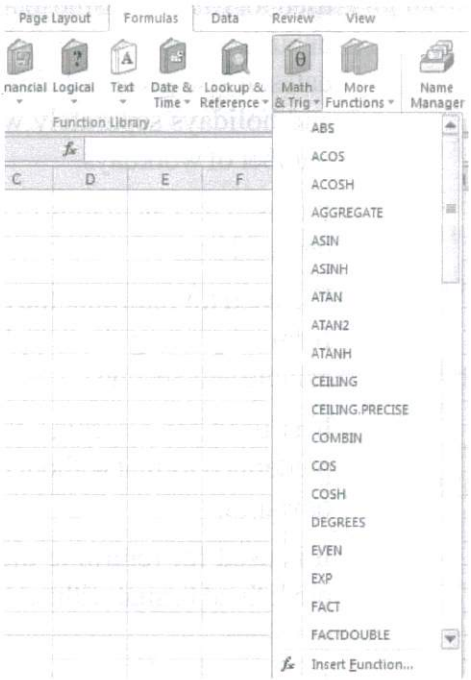
Function	Description
DATEVALUE	It is used for representing the data in the Excel date-time format, by converting the text to numeric value or numbers
DAY	It is used for returning or calculating the day of the month by converting the provided date or serial number
DAYS360	It is used for finding or returning the days present between two provided dates. It calculates the number of days on the basis of either a year of 360 days or twelve-30 days-months.
EDATE	It is used for returning the same date in the serial format, by using the supplied start date. The specified months are added or subtracted from the start date to calculate the past or future dates.
EOMONTH	It is used for calculating or finding out the last day of the month using the given start date and specified month before or after the start date.
MONTH	It is used for extracting or returning the particular month from the supplied or provided date.
NETWORKDAYS	It is used for finding or returning the total number of working or business days present between two dates. Weekends and holidays are excluded while calculating the number.

NETWORKDAYS.INTL	**This is a New Function in Excel 2010**. It is used for calculating the total number of working or business days that are present between the two dates. It also gives out the number of weekends and holidays separately while calculating the number of workdays.
NOW	It is used for calculating or returning the present date and time
TIME	It is used for returning the time in the time zone format by using the supplied values of Hour, Minute and Second.
TIMEVALUE	It is used for returning the current date in a predefined format without taking any arguments or values.
TODAY	It is used for returning the current date in the predefined format without taking any arguments or values.
WEEKDAY	It is used for representing or finding the day of the week by using the supplied date value.
WEEKNUM	It calculates or finds out the week number from the given date.
WORKDAY	It is used for calculating or knowing the date before or after given number of working days and using a specific date as start date.
WORKDAY.INTL	**This is a New Function which has been added to Microsoft Excel 2010**. It is used for providing the valid date before or after the supplied date, by calculating the given number of workdays on the basis of weekends.
YEAR	It is used for representing or extracting the year from a given date.
YEARFRAC	It is used for calculating the year in fractional form, on the basis of two supplied dates.

Math Functions

Math functions are those functions that are used to perform mathematical operations in Microsoft Excel. In Microsoft Excel 2010, you can access the math functions from the **Math & Trig** drop-down menu of the **Function Library** group. PRODUCT, QUOTIENT, POWER, AGGREGATE, MOD, SUM, FACT, EXP, SIN, COS etc. are some of the useful functions available in the **Math & Trig** functions.

The screenshot displaying **Math & Trig** drop-down menu is as shown:



The four basic math operations are PRODUCT, MOD, QUOTIENT and SUM are discussed as follows:

- **Product:** This function calculates the product or multiplication of the numbers in the given cells. **For example:** The resultant product, of two numbers **10** and **20**, using the **PRODUCT** function — **PRODUCT (10, 20)** will be **200**.
- **Quotient:** This function calculates the quotient when one number is divided by another in the specified cells. **For example:** The Quotient obtained by dividing the number **34** by the numeric value **2** using the **QUOTIENT** function— **QUOTIENT (34, 2)** will be **2**.
- **Mod:** This function calculates the remainder when one number is divided by another in the given cells. **For example:** The value of the remainder or Mod obtained by dividing the number **56** by the numeric value **23** using the **MOD** function — **MOD (56, 23)** will be **10**.

- **Summing up Math and Trig Functions:**

Function	Description
ABS	It is used for converting the given or supplied number into its absolute value.
ACOS	It is used for providing the value of a number in arccosine.
ACOSH	It is used for representing the inverse hyperbolic cosine of a number.
AGGREGATE	New function that has been added to Microsoft Excel 2010.It is used for calculating the aggregate value of a list of numbers or multiple arguments.

NOTES

ASIN	It is used for providing the value of a number in arcsine.
ASINH	It is used for or representing the inverse hyperbolic sine of a number.
ATAN	It is used for providing the value of a number in arctangent.
ATAN2	It is used for representing the arctangent of the supplied x coordinate and y-coordinate.
CEILING	It is used for returning the number after rounding it up to the nearest possible integer number or value. The number is rounded up or down on the basis of the sign the number has.
CEILING PRECISE	It is used for returning the number by rounding it up to the nearest possible integer number or value. The number is always rounded up irrespective of the number's sign.
COMBIN	It is used for providing all the possible combinations of objects or group of objects for the specified or given number of values or items.
EVEN	It is used for returning the positive or negative number by rounding it up or down to the even number that is nearest to the supplied number.
EXP	It is used for returning the number in exponential form by raising the power to the number supplied within the function.
FACT	It is used for calculating or finding out the factorial of a number.
FLOOR	It is used for returning the number by rounding it down to the nearest possible integer number or value. The number is rounded up or down on the basis of sign of the number.
FLOOR PRECISE	It is used for returning the number by rounding it down to the nearest possible integer number or value. The number is always rounded up irrespective of the number's sign.
GCD	It is used for calculating or providing the greatest common divisor of a given or supplied number.
INT	It is applied or used on a real or fractional number to convert it into the nearest possible integer.
LCM	It is used for calculating the least common multiple or smallest common factor of a given or supplied number.
MMULT	It is used for returning the product of two arrays as a matrix product.
MINVERSE	It is applied on a supplied array matrix to calculate or find out the inverse matrix.

ODD	It is used for returning the positive or negative number by rounding it up or down to the odd number that is nearest to the supplied number.
RAND	It is used for returning a number ranging between 0 to 1, randomly.
SQRT	It is applied to a given number to calculate or return the positive square root of that number.
SUMSQ	It is applied on the list of numbers to return to determine the sum of the squares of the numbers passed or referred.
TRUNC	It is used for truncating or trimming the number by removing or extracting the decimal points or fractional part from the number. Thus, it converts the given number to an integer number or value.

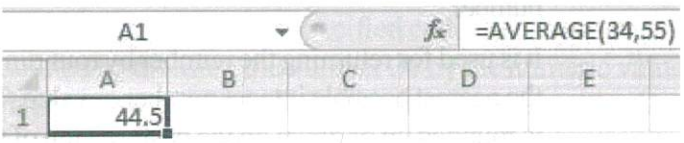
Statistical Functions

Statistical Function is present inside **More Functions** dropdown box. The user needs to browse **More Functions** in order to access **Statistical Function**. **Statistical** function plays an important role in Microsoft Excel. There are various functions available in **Statistical** function like **AVERAGE, MAX, MIN, COUNT, MEDIAN, SLOPE, SKEW, FREQUENCY,** etc.

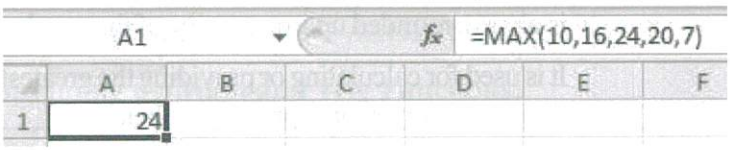
The basic statistical functions are described as follows:

- **AVERAGE: It gives the average of the given numbers.**

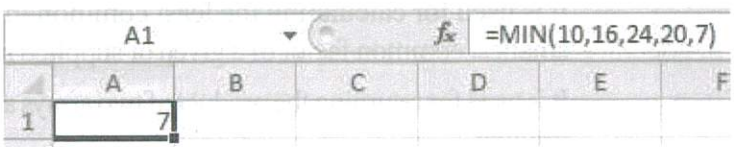
The screenshot representing **AVERAGE** function is as shown:



- **MAX:** It is a function used to return the maximum value from the values passed in arguments. The screenshot representing **MAX** function is as shown:

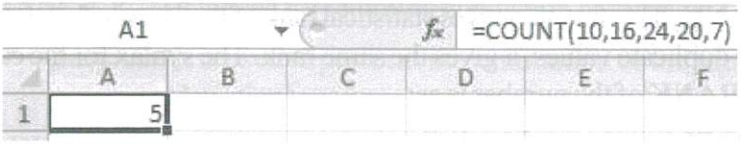


- **MIN:** It is a function used to return the minimum value from the values passed in arguments. The screenshot representing **MIN** function is as shown:



- **COUNT:** It returns the count of the number of arguments.

  The screenshot representing **COUNT** function is as shown:



- **MEDIAN:** This function returns the middle number of the set of numbers.

  Syntax of **MEDIAN** function is—MEDIAN (number1, number2, …), where, number 1 represents the first number and number 2 represents the second number. Each number is separated from the other with the help of a comma operator.

  The middle number can be easily found in case of odd numbers but when the number is even, it is found by calculating the average of the middle two numbers.

- **AVEDEV:** This function calculates the average deviation of the given set from mean. Syntax of **AVEDEV** function is—AVEDEV (number1, number2, …)

  The equation for the average deviation is as:

$$\frac{1}{n}\sum|x-\bar{x}|$$

  Where,

  n is the total number of values,

  x takes each and every value which is present in the set,

  $\bar{x}$ bar is the average of groups of values.

  Suppose, you have 5 numbers which are 1, 2, 3, 4 and 5. First the mean of five numbers is calculated, which is 3. Then the average deviation is calculated using above formula.

$$\frac{1}{n}\sum|x-\bar{x}| = \frac{1}{5}\left(|(3-1)|+|(3-2)|+|(3-3)|+|(3-4)|+|(3-5)|\right)$$

$$= \frac{1}{5}(2+1+0+1+2)$$

$$= 1.2$$

- **CORREL:** It calculates the Pearson Product- Moment Correlation Coefficient for the two sets of given values. Syntax of **CORREL** function is—CORREL(array1,array2,…), where, **array1** is cell range of the first cell and **array2** is cell range of the second cell.

  The equation is as follows:

$$r = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2\sum(y-\bar{y})^2}}$$

NOTES

Where,

$\bar{x}$ and $\bar{y}$ bar are mean of the group of values.

- **RANK:** This function gives statistical rank of the given value. In case there are duplicate values, it gives the same rank. The syntax for the calculation of **RANK** of the number is as:

  RANK (number, ref, [order])

- **STDEV:** This is the function which calculates the standard deviation for a given set of values.

  The equation is like:

$$Sample\ S\tan dard\ Deviation = \sqrt{\sum \frac{(x-\bar{x})^2}{(n-1)}}$$

  Where,

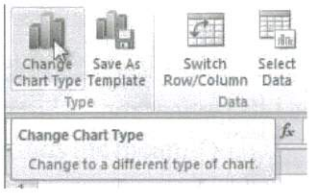
  x is the group of values and n is the total number of values.

- **Summing up Statistical Functions:**

Functions	Description
AVERAGEIF	It is used to calculate the average according to certain criteria.
AVERAGEIFS	It is used to calculate the average according to a set of criteria.
BETA:DIST	It is used for returning beta cumulative distribution function.
BETA:INV	It is used for returning the inverse of the beta cumulative distribution function.
BINOM:DIST	It is used for returning binomial distribution probability.
BINOM:INV	It is used for returning the inverse of the binomial distribution probability.
CHISQ:DIST	It is used for returning chi-squared distribution.
CHISQ:DIST.RT	It is used for returning chi-squared distribution of right tailed probability.
CHISQ.INV	It is used for returning the inverse of chi-squared distribution.
CHISQ.INV.RT	It is used for returning the inverse chi-squared distribution of right tailed probability.
CHISQ.TEST	It is used for returning the values of chi-squared distribution.
COUNTA	It is used for returning total number of non-blanks in the cells.
COUNTBLANK	It is used for returning total number of blanks in the cells.
COUNTIF	It is used for returning the total number of cells on the basis of certain criteria.

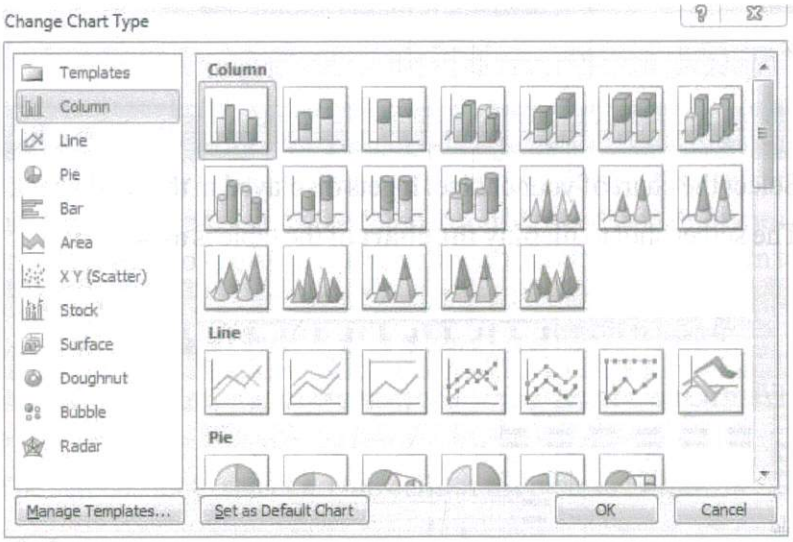
COUNTIFS	It is used for returning total number of cells on the basis of set of criteria.
COVARIANCE.P	It is used for returning population covariance.
DEVSQ	It is used to perform the summation of the square of the deviations.
EXPON.DIST	It is used for returning exponential distribution.
F.INV	It is used for returning the inverse of F probability distribution.
F.DIST.RT	It is used for returning the right tail F probability distribution.
FORECAST	It is used for predicting future values from a given value.
FREQUENCY	It is used for finding the repetition of values within a range.
GEOMEAN	It is used to perform the geometric mean.
HARMEAN	It is used to perform the harmonic mean.
KURT	It is used to perform kurtosis of the given data set.
LARGE	It is used for finding the largest element present in the data set.
LINEST	It is used for returning statistical information determining the graph line on the basis of values of x and y coordinates.
LOGEST	It is used for returning the exponential trend parameter.
LOGNORM.DIST	It is used for returning log normal distribution.
MAXA	It is used for returning greatest value from the argument list.
MINA	It is used for returning smallest value from the argument list.
MODE.MULT	It is used for returning frequently used values.
NORM.DIST	It is used for returning normal cumulative distribution of mean and deviation.
NORM.INV	It is used for returning inverse of the normal cumulative distribution.
PERCENTRANK	It is used to find the percentage rank of any element, present in the data set.
PERCENTILE	It is used to find data set percentile.
POISSON.DIST	It is used for returning position distribution.
QUARTILE	It is used to find data set quartile.
STDEV.P	It is used to find data set population standard deviation.
STDEV.S	It is used for computing standard deviation on the basis of population sample

The screenshot displaying the **Change Chart Type** option is as shown:



2. A **Change Chart Type** dialog box gets displayed on the screen.
3. Choose any chart from the list of chart type, and then press **OK**.

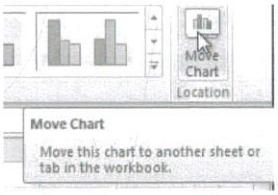
   The screenshot to **choose a chart** from the **Change Chart Type** dialog box is as shown:



Steps to **move chart** to different worksheets are as follows:

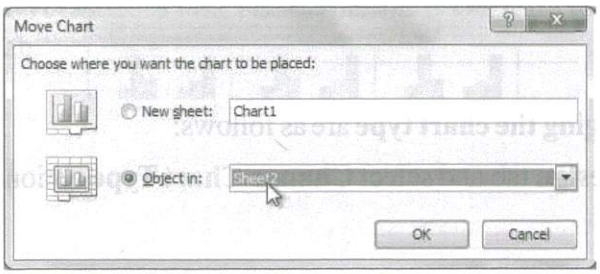
1. Go to **Design** tab, select **Move Chart** command. A dialog box appears.

   The screenshot to display **Move Chart** option is as shown:



2. Select the location where you want to move the chart by filling in the text box **Object in**.

   The screenshot to place the chart to the location as per the user choice is as shown:

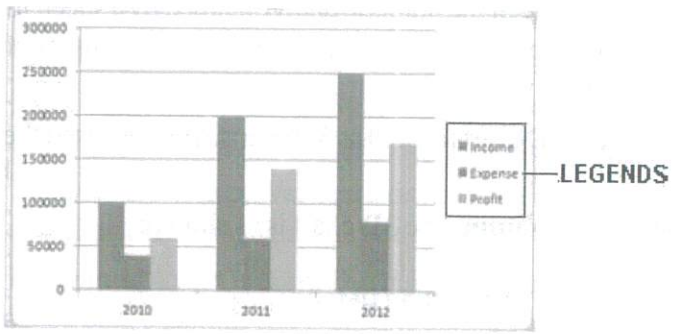


Legends

Legend refers to information about the elements of chart. Legends enable us to understand what information is given by different colors and trend lines.

For example: If a record set has three fields, then each field in chart is represented by a different color.

Snapshot of a chart which has a legend is as shown:



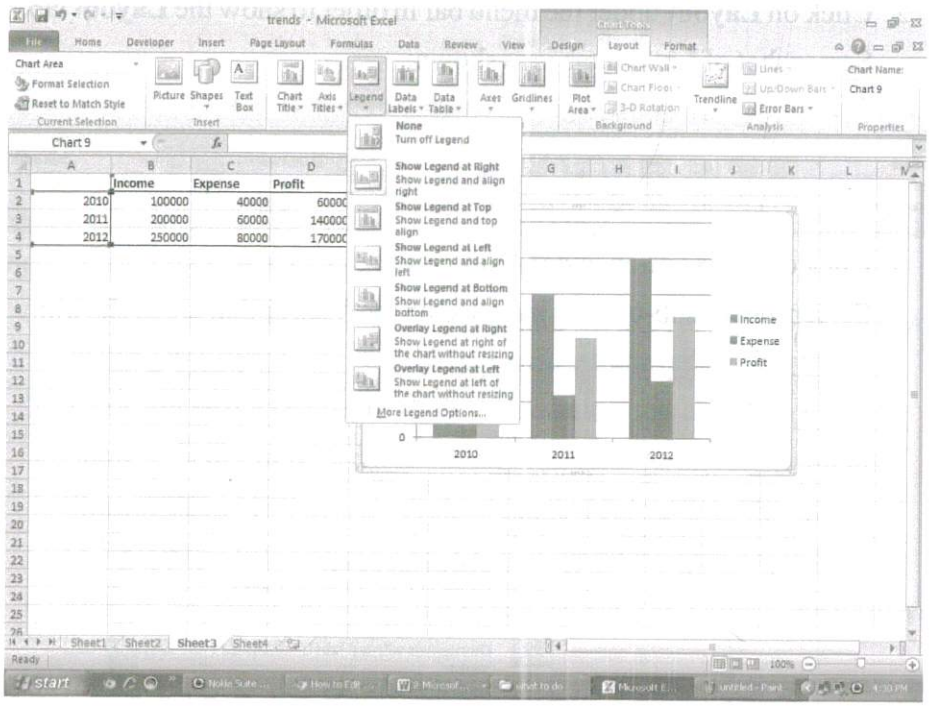
There are three fields shown in this chart: Income, Expense and Profit. Each is represented by a different color.

Legend Options

Steps for formatting or setting legend as per requirement, are as follows:

1. Select chart.
2. Click on **Layout** to switch on **Layout** tab.
3. In this tab, you will find **Legend** option under **Labels** group.

Snapshot of **Legend** in **Labels** group is as shown:



In this option, you will find various choices to set the legend at the left, right, top and bottom of the chart or as **Overlay Legend**. You can change the style as well, by clicking on **More Legend Options** under the same popup menu.

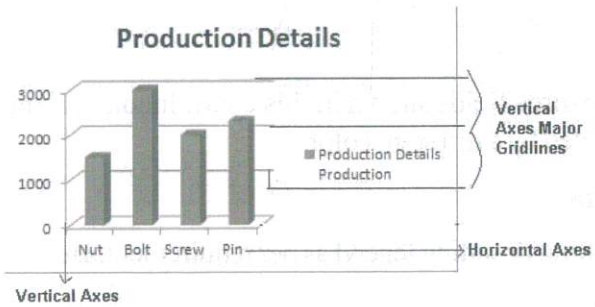
You find the **Format Legend** window also on the right click popup menu of **Legend**.

Formatting Axes and Gridlines Within Charts And Graphs

A chart is a pictorial view of the numeric data contained by a sheet. In Excel 2010, you will find various types of charts in the **Charts** group of **Insert** tab. These can be easily inserted in the worksheet.

Excel provides 2D charts as well as 3D charts. You can insert them according to your need.

Snapshot of a **Column** type **3D** chart is as shown:

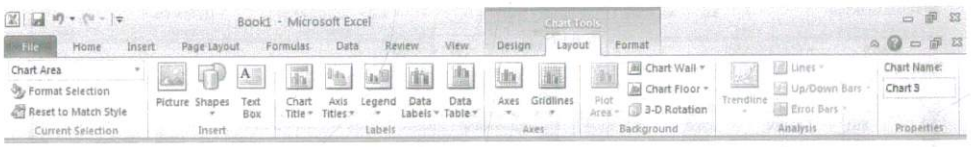


Formatting Axes

Steps needed to format the axes of the chart are as follows:

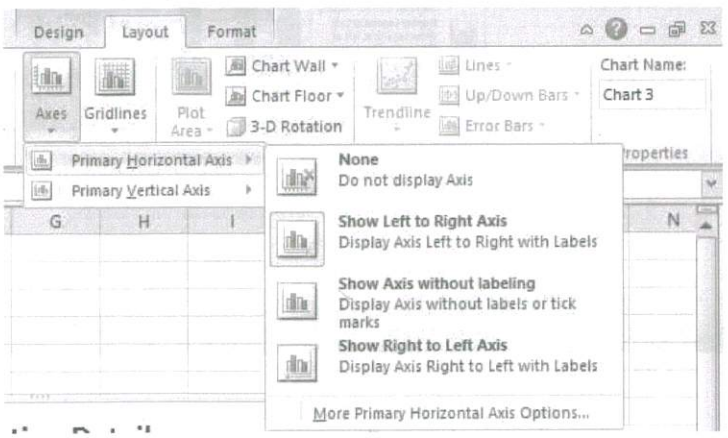
1. First select the chart by clicking on it.
2. Click on **Layout** under the menu bar in order to show the **Layout** tab.

   Screenshot of **Layout** tab is as shown:



3. Click on **Axes** option under **Axes** group.

   Screenshot of sub-options included under **Axes** option are as shown:



4. Within **Axes** option, you will find various choices under both **Primary Horizontal Axes** and **Primary Vertical Axes.**

NOTES

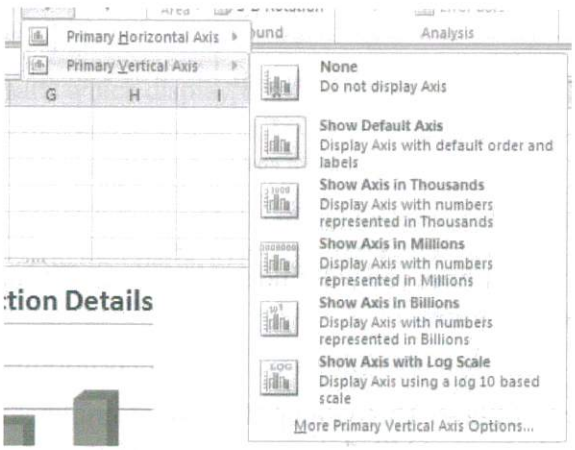
Primary Horizontal Axes

Within this head, you will find the following options:

1. **None**: It is used when there is no need for the axes to be displayed. If you click on this option, the horizontal axes will be removed.
2. **Show Left to Right Axes**: The chart presented above shows this option, as the **Vertical Axes** is on the left moving to the right side.
3. **Show Axes without Labeling**: By applying this option, you can remove only the labels of the axes. It has almost the same effect as the **None** option.
4. **Show Right to Left Axes**: Vertical axis is moved to the right of the chart and the labeling of horizontal axes starts from right, moving to left.
5. **More Horizontal Axes Options**: By clicking on this you will find a **Format Axes** dialog box, enabling you to change the appearance of the axes. In left pane of this dialog box you will find various formatting options for applying on the axes.

Primary Vertical Axes

Screenshot of sub-options of **Primary Vertical Axes** is as shown:



Within this head, you will find following options:

1. **None:** It is used when there is no need for the axes to be displayed. If you click on this option, the vertical axes will be removed.
2. **Show Default Axis:** It will show the default labels and orders.
3. **Show Axis in Thousands:** It will show number format in thousands.
4. **Show Axis in Millions:** It will show number format in millions.
5. **Show Axis in Billions:** It will show number format in billions.
6. **Show Axis with Log Scale:** It will show the log 10 based scale format of the numeric values.

NOTES

7. **More Vertical Axis Options:** On clicking on this you will find a **Format Axis** dialog box, to set the values and apply formatting options.

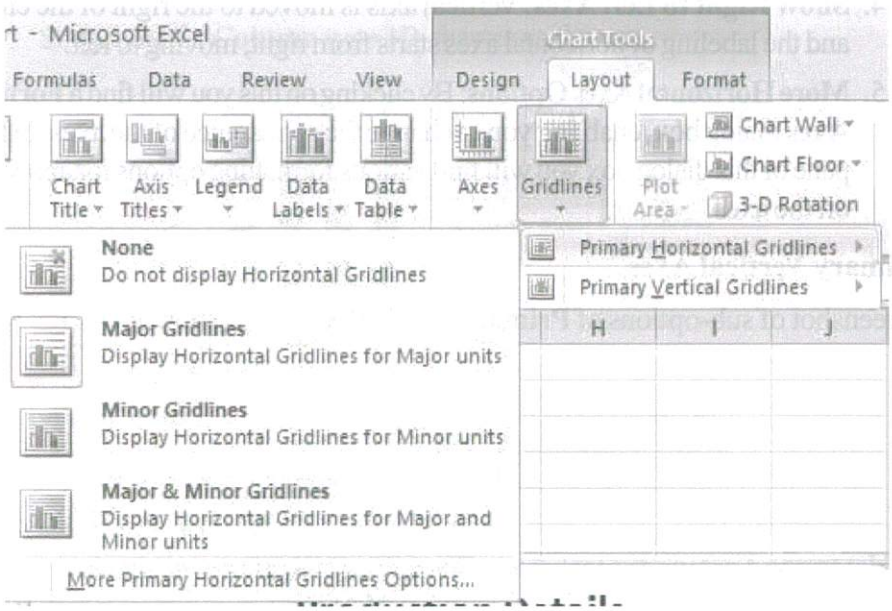
Formatting Gridlines

A chart can have Horizontal as well as Vertical Gridlines. You can customize both of them.

Steps needed to customize the gridlines are as follows:

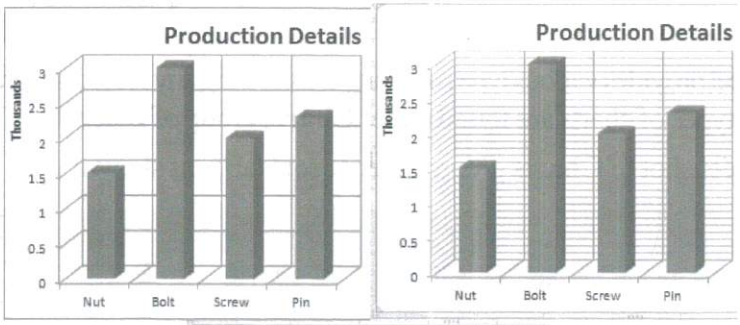
1. Select the chart by clicking on it.
2. Click on **Gridlines** from **Axes** group of the **Layout** tab. You will find two options: **Primary Horizontal Gridlines** and **Primary Vertical Gridlines**.

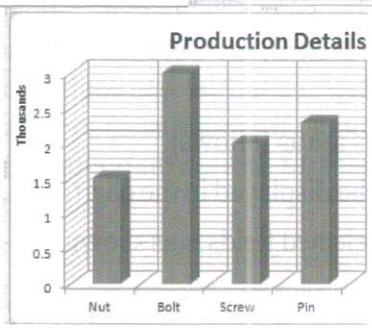
   Snapshot of sub-options of **Gridlines** is as shown:



3. In both of the gridlines you will find same options. The options contained under these heads are:
   - **None:** Click on it if you don't want to display gridlines.
   - **Major Gridlines:** This option helps display gridlines with major units. The gap between gridlines is more than that between minor gridlines.
   - **Minor Gridlines:** Click on it to display gridlines with minor units. The gap between gridlines is less.
   - **Major and Minor Gridlines:** This option helps display Major as well as Minor Gridlines. Major Gridlines will be shown with a slightly dark colour.

Snapshots of **Major**, **Minor** and **Major and Minor Gridlines** for Horizontal Gridlines are as shown:





- **Major Primary Gridlines Options**: Click on it to show a **Major Format Gridlines** Dialog, enabling you to format and color the gridlines.

Setting Up Live Charts

Live charts are charts which display, changing situations graphically. They help to easily understand the current situation. Live Charts are used to compare situations in different scenarios, to enable analysis.

For example: The rise and falls of securities listed in stock market could easily be displayed on the charts, to understand the actual condition.

These charts are prepared for displaying values of different fields, for any small or large record-set. If new values are added to that record set, the charts automatically show these newer changes. Hence, the end users need not concern themselves with the record-set.

For understanding this better, let's take an example. Suppose, there is a Cricket record-set containing the runs of Team 2, after the completion of each over. The first team has already completed its turn and information about the runs they have scored has already been inserted in that record-set.

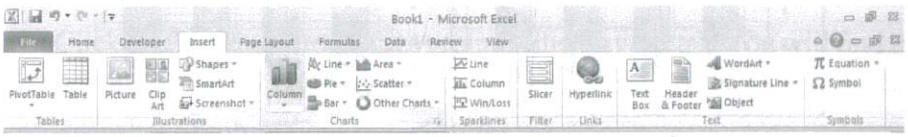
Screenshot of that database is as shown:

	A	B	C
1	Overs	Team 1	Team 2
2	1	5	7
3	2	8	6
4	3	11	5
5	4	14	4
6	5	12	
7	6	10	
8	7	8	
9	8	9	
10	9	10	
11	10	11	

Only ten overs play has been recorded in this example, but as you know the actual game will produce a huge database. Therefore, a pictorial representation of this information would make it easier for viewers to compare and understand the positions of both teams.

Excel provides various types of charts for showing any record-set graphically. Different types of charts are found under **Charts** group of **Insert** tab.

Screenshot of **Charts** group under **Insert** tab is as shown:



For comparing two related terms, the **Column** and **Bar Charts** are considered the best.

Steps to insert these charts are as follows:

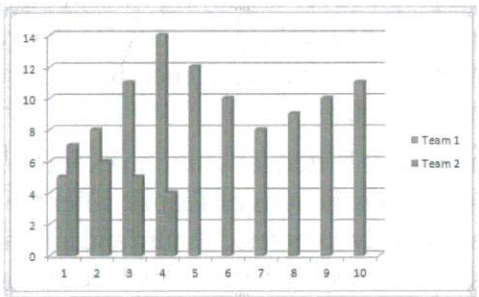
1. Select the fields to be displayed in the chart.

   Screenshot of the selected fields is as shown:

	A	B	C
1	Overs	Team 1	Team 2
2	1	5	7
3	2	8	6
4	3	11	5
5	4	14	4
6	5	12	
7	6	10	
8	7	8	
9	8	9	
10	9	10	
11	10	11	

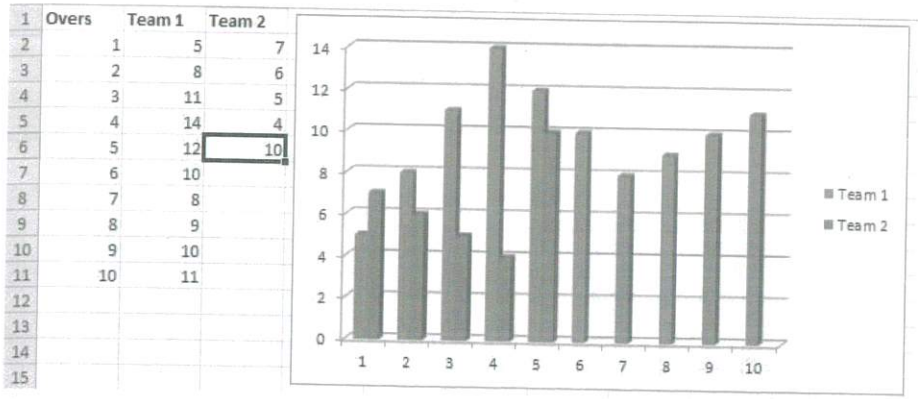
2. Click on either **Column** or **Bar** chart under the **Insert** tab. (You can also insert **Line** chart)
3. Click on any of the charts displayed in this category.

   Screenshot of a **3-D Column** chart is as shown:



A live chart presents the recent changes in the record-set as well. In above example, when second team would complete its 6th over, the runs will be added to the record-set. As soon as the runs are added, the chart will automatically display it.

Screenshot for showing automatic modification in chart, as per the changes in record-set is as shown:



	Overs	Team 1	Team 2
1	1	5	7
2	2	8	6
3	3	11	5
4	4	14	4
5	5	12	10
6	6	10	
7	7	8	
8	8	9	
9	9	10	
10	10	11	

When you will select a chart, three new tab options will appear: **Design, Layout** and **Format**. You can use any of these options for modifying and formatting the inserted chart. Some of the important options for making the live charts more understandable are discussed below:

1. **Chart Layout:** For adding a chart title, you can go to **Design** tab and click on any of the pictures displayed under **Chart Layout** group.
2. **Move Chart:** For displaying a chart in different locations, you can click on **Move Chart** button of **Layout** group under **Design** tab.
3. **Select Data:** For selecting any other data range or modifying legends and axes labels for a particular chart, you can click on **Select Data** of **Data** group under **Design** tab.

Find, Replace and Go to

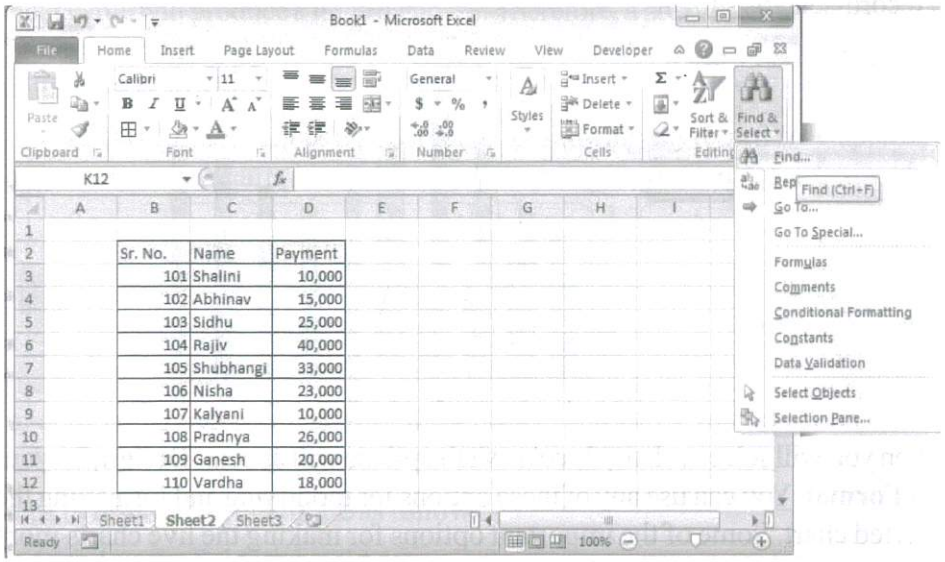
Excel 2010 provides some options to find specific data, replace previous data with new data, and go to specific cell. These are done by **Find**, **Replace** and **Go to** command. **Find** command is used to find quickly specific text, number in worksheet. **Replace** command is used to find and replace any data with new data. **Go to** command is used to jump on a specific cell or range of cells. These commands are available on **Editing** group on **Home** tab. Let us learn these commands one by one in detail. First, we will learn to find text or number in worksheet.

Find:

Steps to **Find** text or number are as follows:

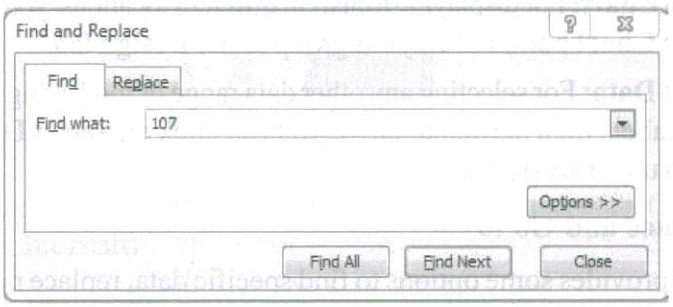
1. Click on **Editing** group on **Home** tab
2. Click **Find& Select** on **Editing** group.
3. Click on the **Find** command.

The screenshot of **Find & Select** is as shown:



4. On clicking, **Find and Replace** dialog box appears. Type a text or number that you want to find.

   The screenshot displaying **107** number in **Find what** box is as shown:



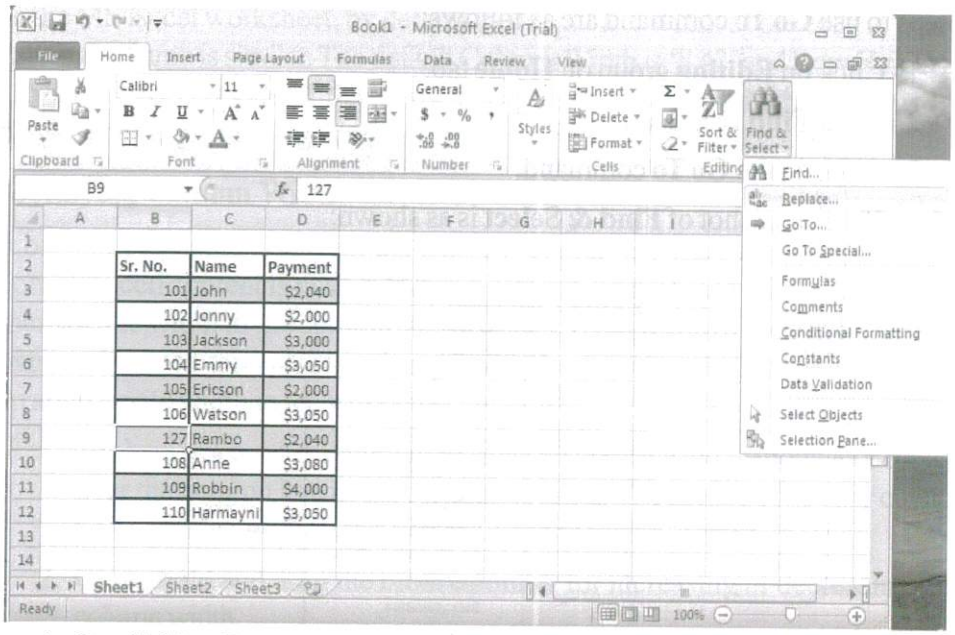
5. Click on **Find Next** button. It selects the cell where 107 numbers placed.
6. If you click on **Find All** button, the location of all the occurrences of that number or text is displayed.

Replace:

Steps to **Replace** text or number are as follows:

1. Click on **Editing** group on **Home** tab
2. Click **Find & Select** on **Editing** group.
3. Click on the **Replace** command.

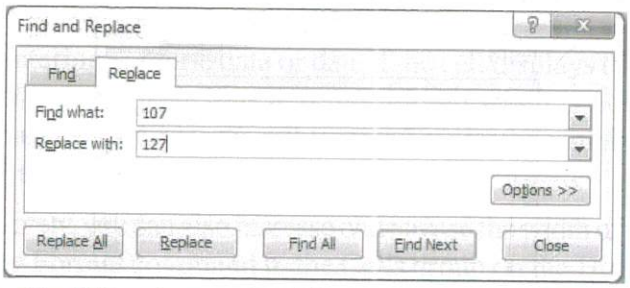
The screenshot of **Replace** is as shown:



Sr. No.	Name	Payment
101	John	$2,040
102	Jonny	$2,000
103	Jackson	$3,000
104	Emmy	$3,050
105	Ericson	$2,000
106	Watson	$3,050
127	Rambo	$2,040
108	Anne	$3,080
109	Robbin	$4,000
110	Harmayni	$3,050

4. On clicking **Replace**, **Find and Replace** dialog box appears. Type a text or number in **Find what** and **Replace with** box.

   The screenshot of displaying **107**number in **Find what** and**127** number in **Replace with** textbox is as shown:



5. Click on **Find Next** button. It will select cell where **107**number is placed.
6. Click on **Replace** button. The number**107**is replaced with **127**.

   The screenshot of table after replacing **107** with **127** using **Replace** button is as shown:

Sr. No.	Name	Payment
101	John	$2,040
102	Jonny	$2,000
103	Jackson	$3,000
104	Emmy	$3,050
105	Ericson	$2,000
106	Watson	$3,050
127	Rambo	$2,040
108	Anne	$3,080
109	Robbin	$4,000
110	Harmayni	$3,050

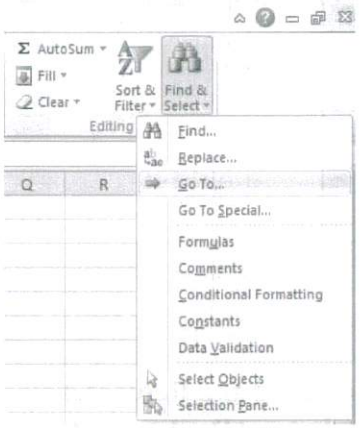
7. If you click on **Replace all**, it will replace all the occurrences of the 107 and replace it with 127.

Go To:

Steps to use **Go To** command are as follows:

1. Click on **Editing** group on **Home** tab.
2. Click **Find & Select**.
3. Click on the **Go To** command.

   The screenshot of **Find & Select** is as shown:

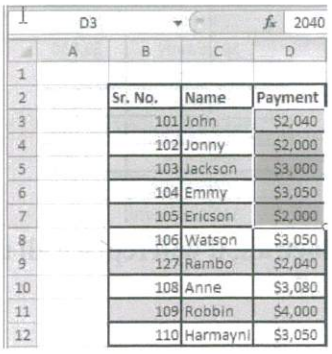


4. On clicking **Go To, Go To** dialog box appears that prompts to enter reference. Enter the cell reference where you want to jump, say **D3:D7**.

   The screenshot of **Go To** dialog box is as shown:

5. Click **OK** button. The cells**D3 to D7**are selected.

   Screenshot of table after clicking **OK** button is as shown:



D3 | 2040

	A	B	C	D
1				
2		Sr. No.	Name	Payment
3		101	John	$2,040
4		102	Jonny	$2,000
5		103	Jackson	$3,000
6		104	Emmy	$3,050
7		105	Ericson	$2,000
8		106	Watson	$3,050
9		127	Rambo	$2,040
10		108	Anne	$3,080
11		109	Robbin	$4,000
12		110	Harmayni	$3,050

2.3.3 Modifying and Merging Rows and Columns

In the MS Excel worksheet, by default the height and width of the cells in every row and column is similar. The default Column Width is '8.43' and Row Height is '15'. MS Excel provides different methods for modifying column width and row height including wrapping of text and merging of cells.

Modifying Column Width

It becomes essential to modify the width of a column in the worksheet when the complete cell content is not visible or displayed. To make it visible you have to increase the width of the column. Additionally, if the width of the cell is more or extra and the cell content is less then you can decrease the width of the cell to give an appropriate width to the worksheet column.

1. To change or modify the column width, position the mouse pointer or cursor over the column line in the column heading. The mouse pointer or cursor will now change from the White Cross to Double-Arrow.
2. Click, hold and drag the mouse pointer for increasing or decreasing the column width.
3. Now release the mouse pointer. See the column width of the selected column is increased and changed and the complete cell content is visible. Similarly increase the column width also so that the complete cell content will be visible. You can also change the column width of range of columns together by selecting them and applying the command.
4. While entering numeric data or date if the cell displays the pound signs (########) then it specifies that the column width is not sufficient or appropriate for displaying the cell content. To view the complete cell content, increase the width of the column.
6. Alternatively, you can also increase or decrease the width of the column by selecting Format command in the Cells group on the Home Tab. If you select the option 'Column Width...' then the Column Width dialog box will appear. Enter the new value for changing the column width and press 'OK'. You can also select the option 'AutoFit Column Width' or 'Default Width...'. When you select the option 'AutoFit Column Width' then MS Excel will automatically increase or decrease the Column Width as per the cell content.
7. When you press 'OK' then the column width will be increased.

AutoFit Column Width

As discussed, the AutoFit Column Width feature automatically set's the column width to fit its content. One method we have already discussed that is using the Format option. Alternatively, select the cell for formatting and position the mouse cursor or pointer above the column line in the column heading. The White Cross Cursor will now become a Double-Arrow Cursor. Now when you double-click the mouse then the Column Width will automatically change to fit the cell content. Similarly, you can change the Row Height.

NOTES

Modifying Row Height

You have learnt how to modify the Column Width of a cell. Similarly, the Row Height of a cell can also be modified.

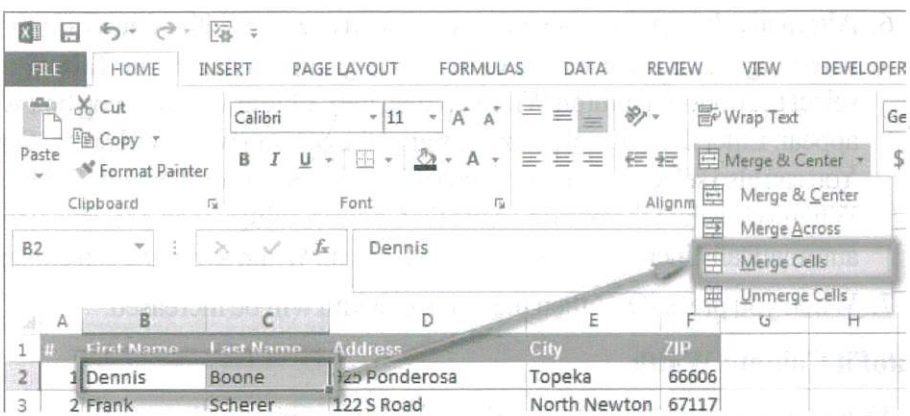
1. To change or modify the row height, position the mouse pointer or cursor over the row line in the row heading. The mouse pointer or cursor will change from the White Cross to Double Arrow.
2. Click, hold and drag the mouse pointer for increasing or decreasing the row height.
3. Now release the mouse pointer. See the row height of the selected Row 2 is increased and changed. Similarly you can increase the row height of the other rows in the worksheet.
4. Alternatively, you can also increase or decrease the height of the row by selecting Format command in the Cells group on the Home Tab. If you select the option 'Row Height...' then the Row Height dialog box will appear. Enter the new value for changing the row height and press 'OK'. You can also select the option 'AutoFit Row Height'.

When you select the option 'AutoFit Row Height' then MS Excel will automatically increase or decrease the Row Height as per the cell content.

Merging Rows and Columns

For merging rows and columns, follow the following steps.

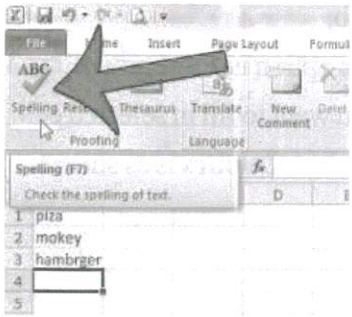
1. Select the cells that you wish to merge.
2. Click on merge and center command to open drop down menu in the alignment group of Home tab.
3. Click on the option as per your requirement. An illustration is given below.



2.3.4 Adding Spellcheck in Spreadsheet

To add spellcheck in spreadsheet, follow the following steps.

1. Click the **Review** tab on the ribbon.
2. Click **Spelling.**



3. If the program finds spelling mistakes, a dialog box appears with the first misspelled word found by the spelling checker.
4. After you decide how to resolve the misspelling (ignoring it, adding it to the program's dictionary, or changing it), the program moves to the next misspelled word.

   Alternatively, you can press F7 key to apply spellchecker.

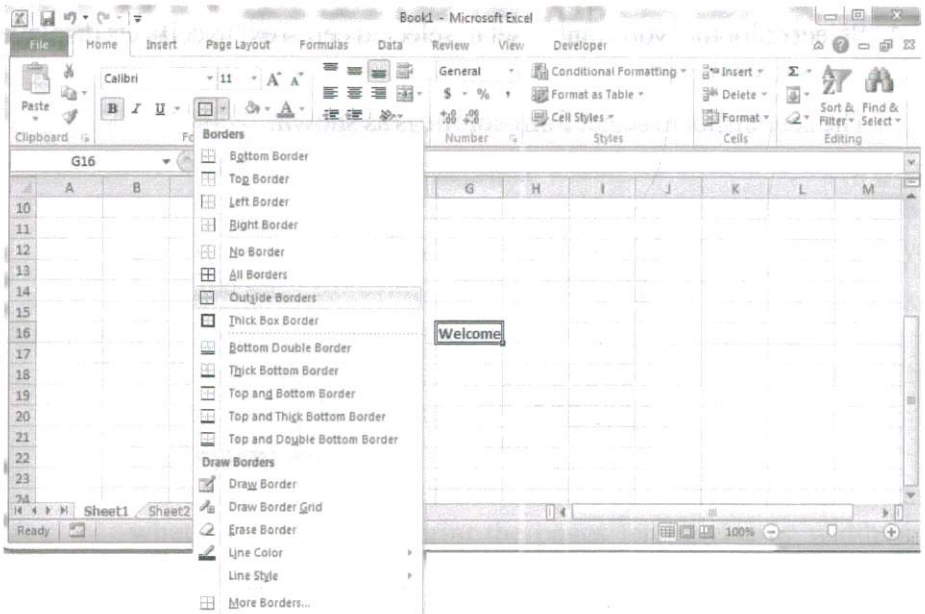
Adding Borders and Colors to Cells

To set border

Steps to set **border** are as follows:

1. Select the cell.
2. Go to **Home** tab.
3. Click on **Borders** option in **Font** group.
4. Select Border style that you want to use.

   The screenshot to select **Borders** is as shown:



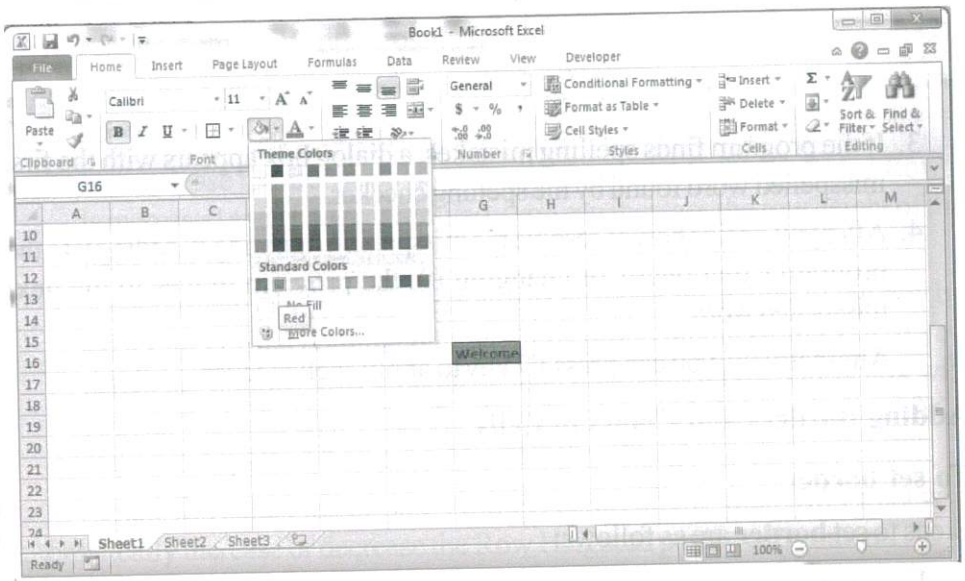
To set Fill cell colour

Steps to **Fill cell colour** are as follows:

1. Select the cell.

2. Go to the **Home** tab.
3. Click on **Fill colour** option in **Font** group.
4. Select color that you want to fill in selected cell.

   The screenshot to select **Colours** is as shown:

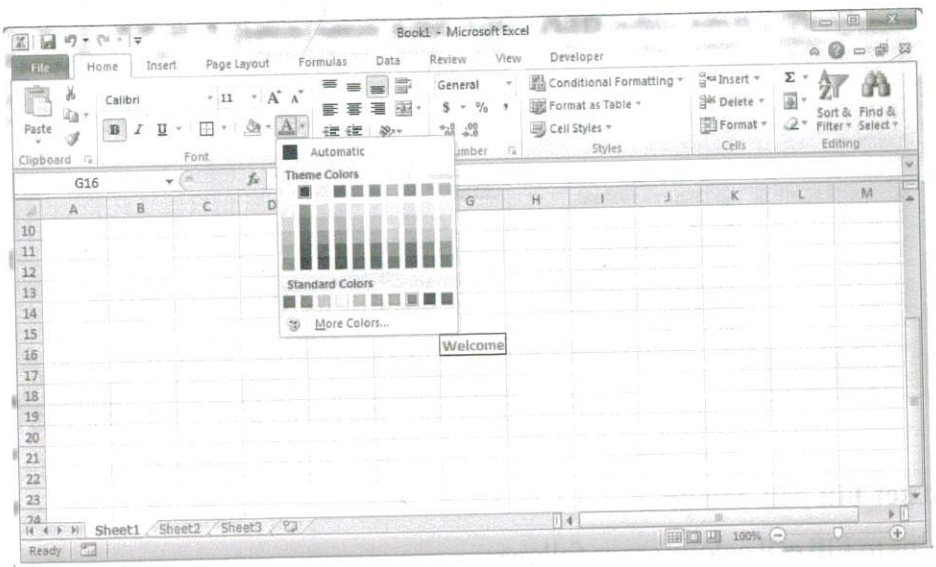


To set the Font colour

Steps to set the **Font colour** are as follows:

1. Select the cell.
2. Click on **Home** tab.
3. Click on **Font colour** option in **Font** group.
4. Select color that you want to set in selected cell. Text in cell gets displayed with selected color.

   The screenshot to select **Font colour** is as shown:

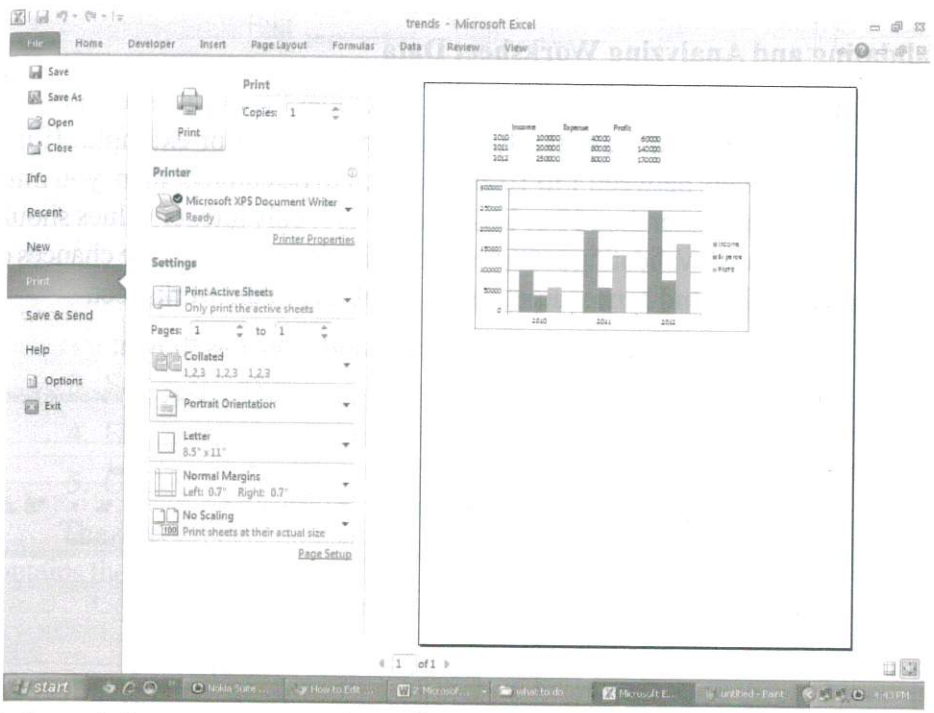


Printing a Worksheet/Workbook

You can print all pages of a worksheet or only selected page(s) by using **Print** option of **File** menu.

NOTES

Snapshot of **Print** options is as shown:



Before printing, you can set print styles as per your requirement. While printing a document, there are various settings available. These are as follows:

1. **Copies:** You can set number of copies to be printed as well as select the pages to be printed.
2. **Printer:** Select printer, if there are more than one printer attached. Otherwise, Excel will automatically recognize the attached printer.
3. **Settings:** In settings, you will find the following options:
   - **A. Print** option, which gives you three choices— **print active sheet, entire workbook** or **print selection**. You can select whichever you need and see the preview of the printing layout on the right side.
   - **B. Pages:** Here, you can set the range of pages to be printed..
   - **C. Collated** refers to printing the pages one by one and **Uncollated** means printing the required copies of first page, then those of second page and so on.
   - **D. Portrait** and **Landscape Orientation** options leave you to decide whether you want to print the pages lengthwise or widthwise, respectively.
   - E. You can set the **Page Type** for the print to be taken. In this snapshot, **Letter** size is selected.

F. You can set **Margin** as well. By default, it is set as **Left: 0.7" Right: 0.7"**.

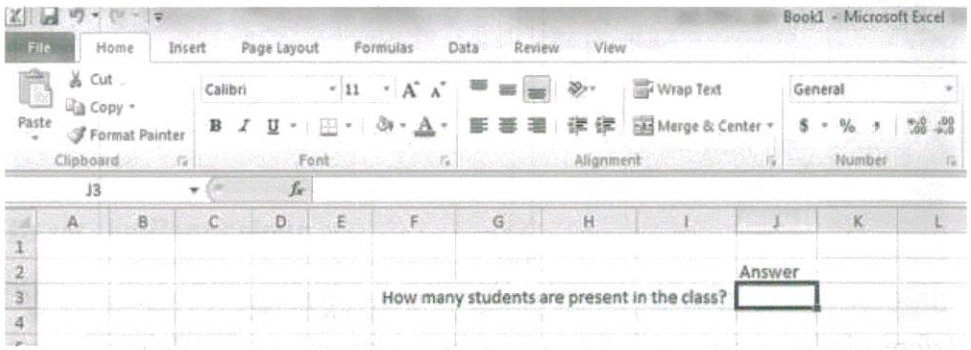
G. You will find some scaling options as well, which are helpful if you want to compress or enlarge the size of the content.

At last, you click on **Print** button on top, to take the final print out(s).

Validating and Analyzing Worksheet Data

Validation is important aspect of MS Excel; it provides the facilities to enter only those values as input in the cell which are appropriate. For example: If in a worksheet, numbers between 1 to 10 are required to be entered, then, you must not enter number greater than 10 or less than 1. Also, only integer values should be present in the cell. Validating provides constraints that eliminate the chances of entering wrong data and hence increases the reliability of the worksheet.

The screenshot displaying an example of validation is as shown:



As shown in the screenshot, in the questions like "How many students are present in the class?" The number must be less than or equal to total number of students in class and greater than or equal to zero. In validating and analyzing, there are certain terms that require understanding. These are explained in the succeeding sections.

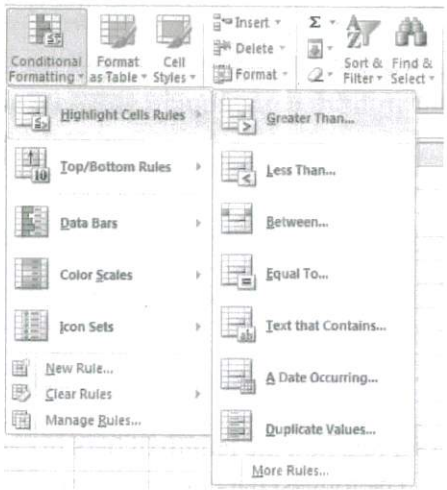
Conditional Formatting

Conditional formatting is a tool of formatting a cell of the worksheet that contains some condition. In the conditional formatting there are different types of rules, bars of option, color scale, etc. All these tools can be used to make the worksheet formatted according to the condition provided by the user. It helps the user to analyze the data in worksheet. You can use the conditional formatting to highlight or change the color of the cell. There are many mathematical relations present in the MS Excel 2010 such as greater than less than, between, equal to, etc.

Steps to apply conditional formatting are as follows:

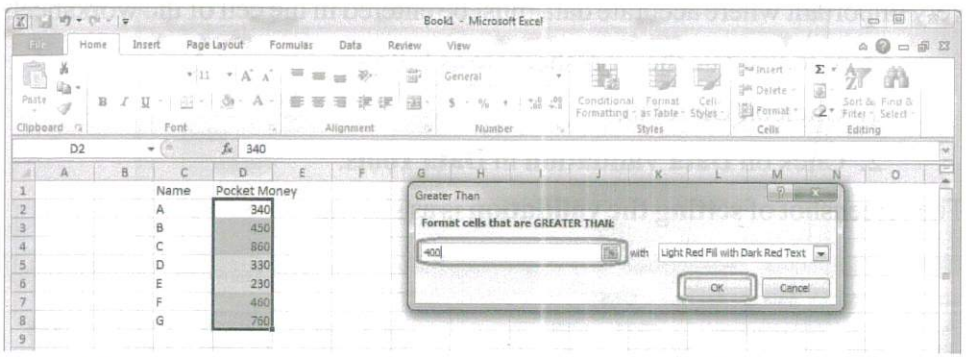
1. Click on **Home** tab.
2. Click on **Conditional Formatting**.

The screenshot of selecting the **Conditional formatting** is as shown:



3. Select **Highlight Cells Rules** and then, select **Greater Than.**
4. Fill the value in **Greater Than** Text area.
5. Click **OK** button.

The screenshot of output displaying the cell, outlined with red color, which contains the value greater than **400** is as shown:



Other options like Data bars are used to see the difference between the values in the cell of the worksheet.

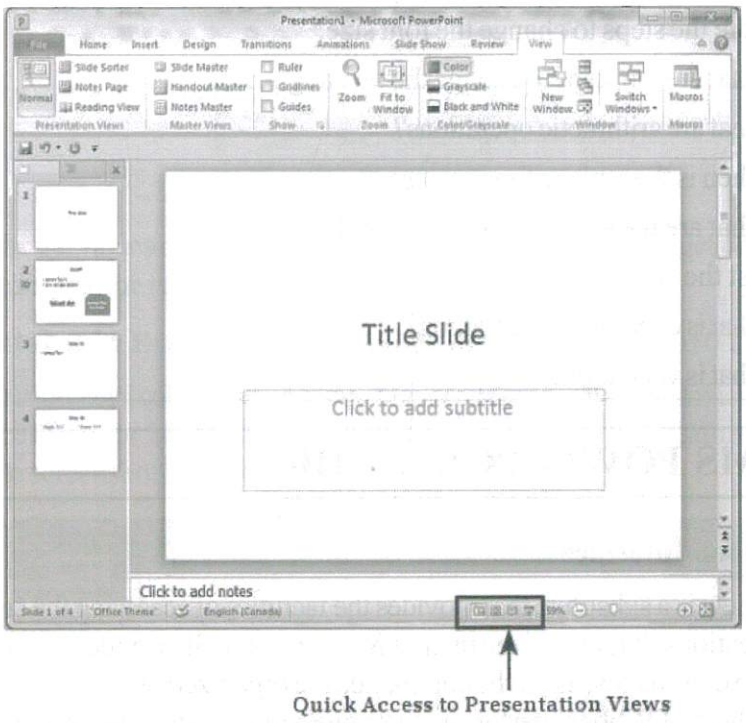
Steps to format the worksheet with a bar are as follows:

1. Click on **Home** tab.
2. Click on **Conditional Formatting**.
3. Select **Data Bars**.
4. Click on the different Color bar.

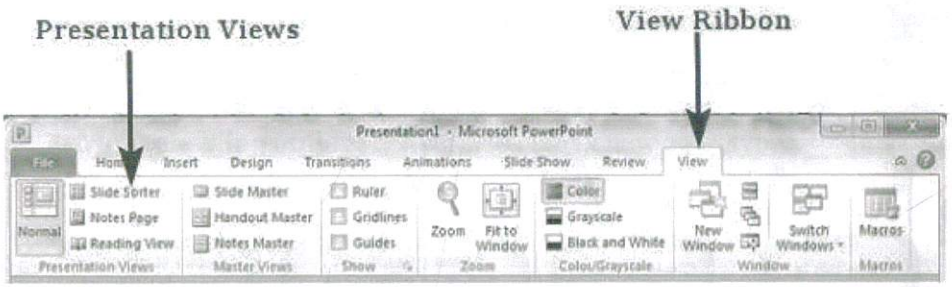
Views in Slides

PowerPoint views can be accessed from two locations.

- Views can be access quickly from the bottom bar just to the left of the zoom settings



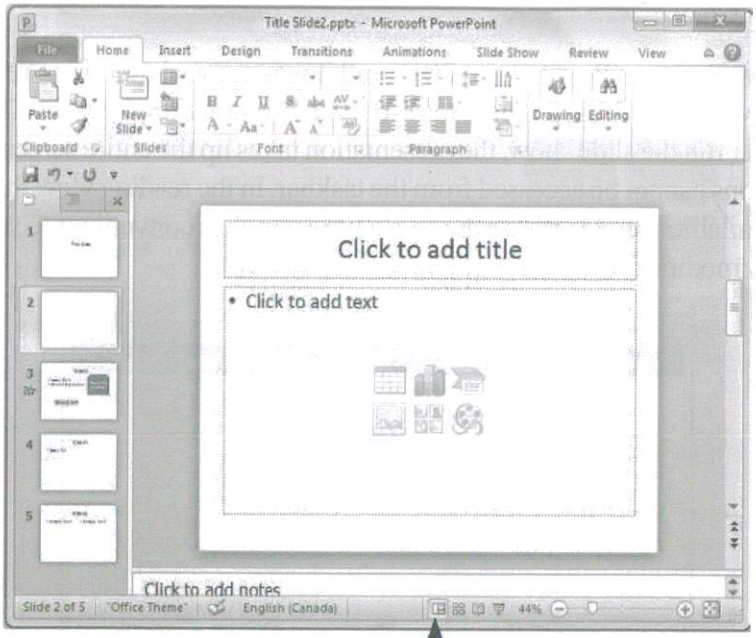
- Views can also be access from the Presentation Views section in the View ribbon



A short description of the different views and their features.

Normal View:

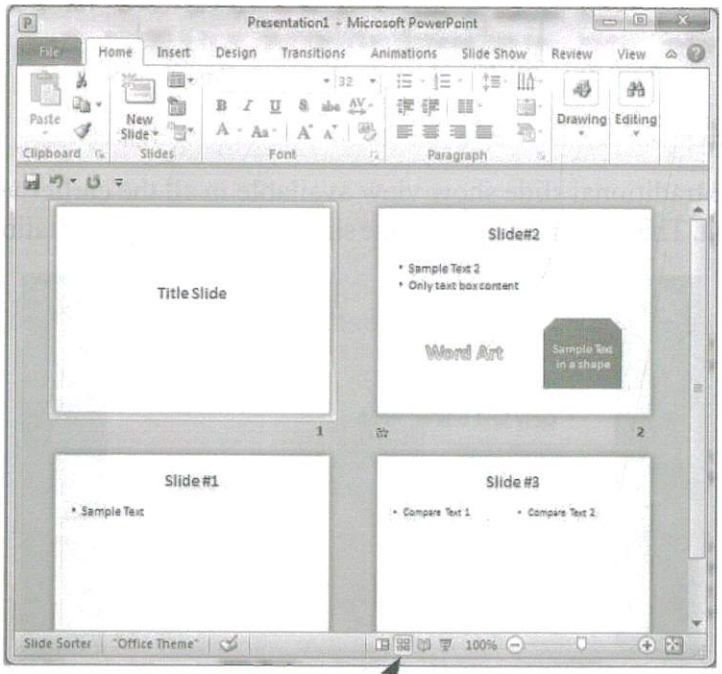
This is the default view in PowerPoint and this is primarily used to create and edit slides. User can create/ delete/ edit/ rearrange slides, add/ remove/ modify content and manipulate sections from this view.



Normal View icon

Slide Sorter View:

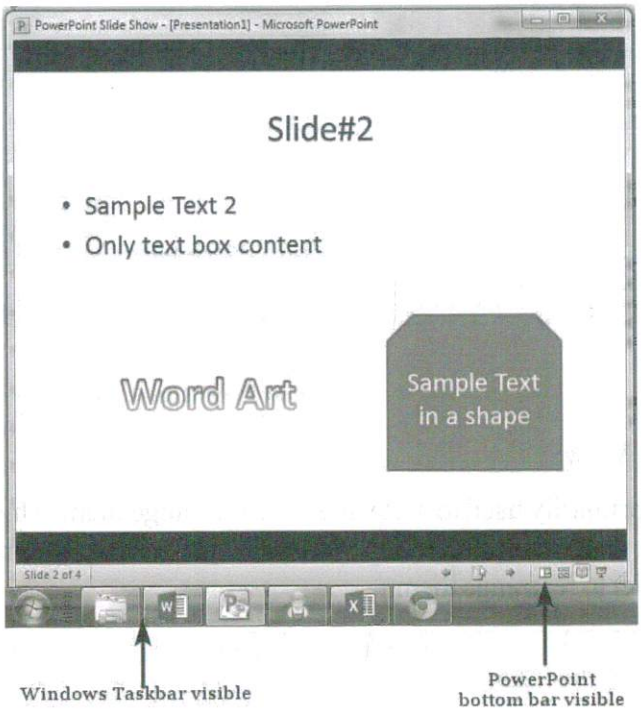
This view is primarily used to sort slides and rearrange them. This view is also ideal to add or remove sections as it presents the slides in a more compact manner making it easier to rearrange them.



Slide Sorter View icon

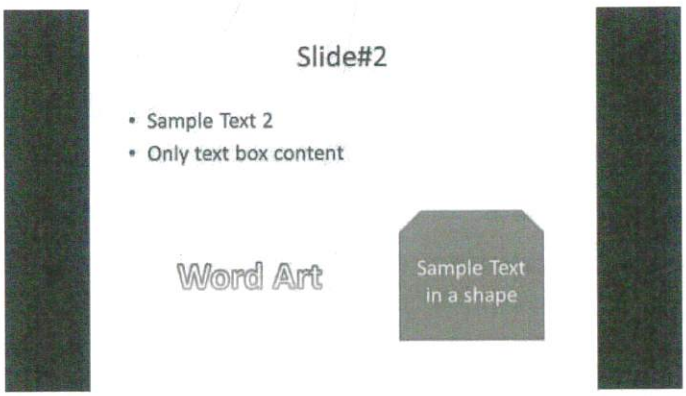
Reading View:

This view is new to PowerPoint 2010 and it was created mainly to review the slide show without losing access to rest of the Windows applications. Typically when User run the slide show, the presentation takes up the entire screen so other applications cannot be accessed from the taskbar. In the reading view the taskbar is still available while viewing the slide show which is convenient. User cannot make any modifications from this view.

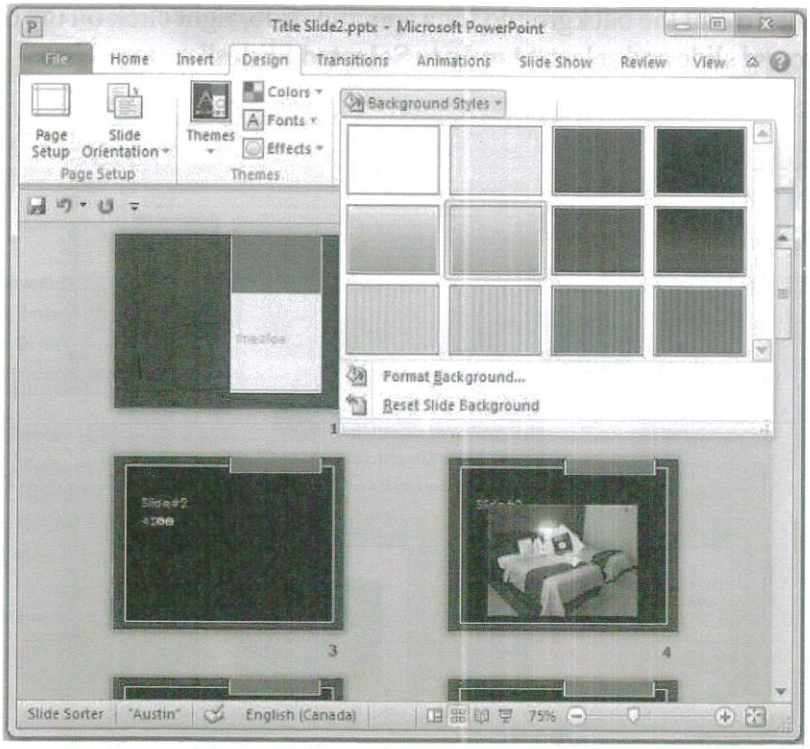


Slide Show:

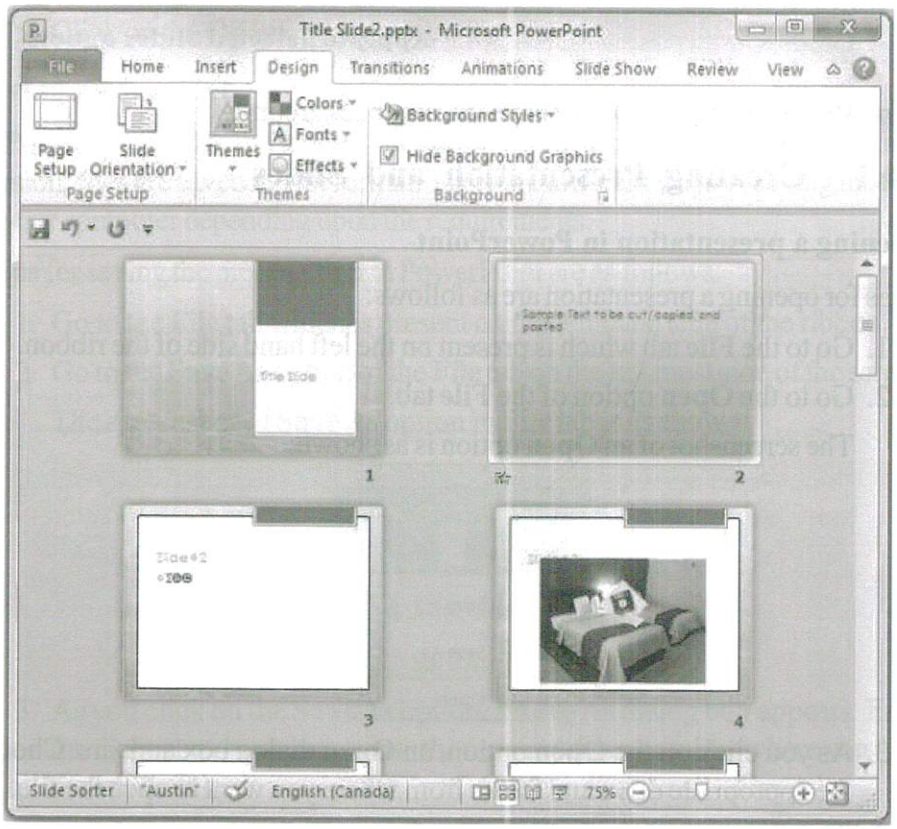
This is the traditional slide show view available in all the earlier versions of PowerPoint. This view is used to run the slide show during presentation.



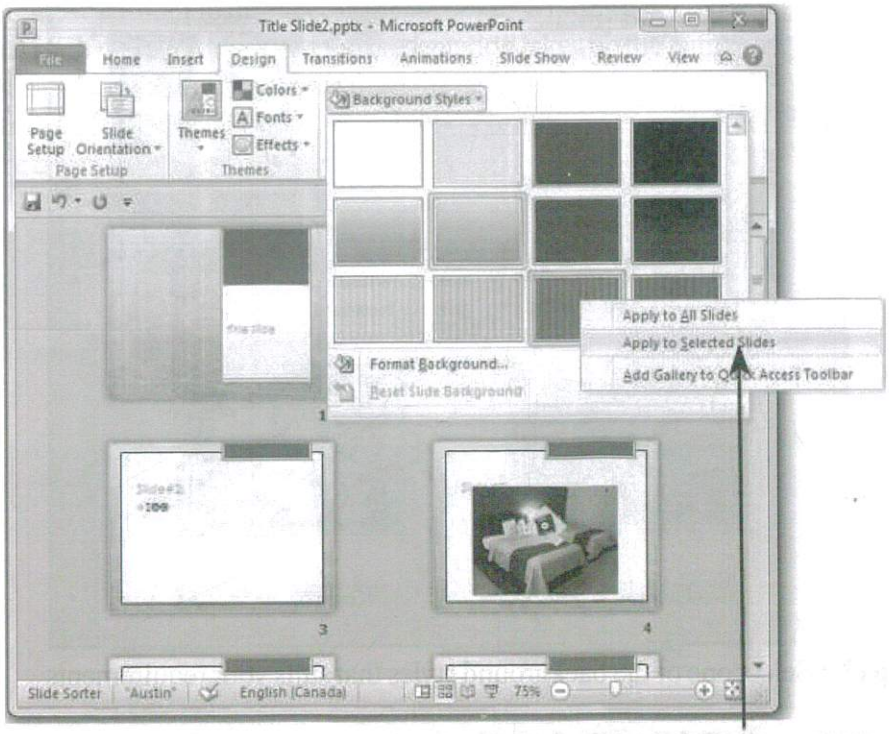
Step (1): In the **Design** ribbon, under the **Background** group click on the**Background Styles** command.



Step (2): Select one of the background styles that suits your requirements



Step (3): To edit the background for a specific slide, right click on the desired background slide and select "**Apply to Selected Slides**"



Apply to Selected Slides option

Step (4): Selected slide(s) now have the new background.

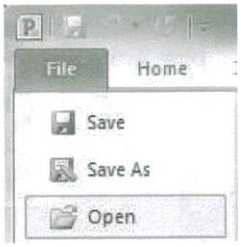
2.4.1 Creating Presentation and Slides

Opening a presentation in PowerPoint

Steps for opening a presentation are as follows:

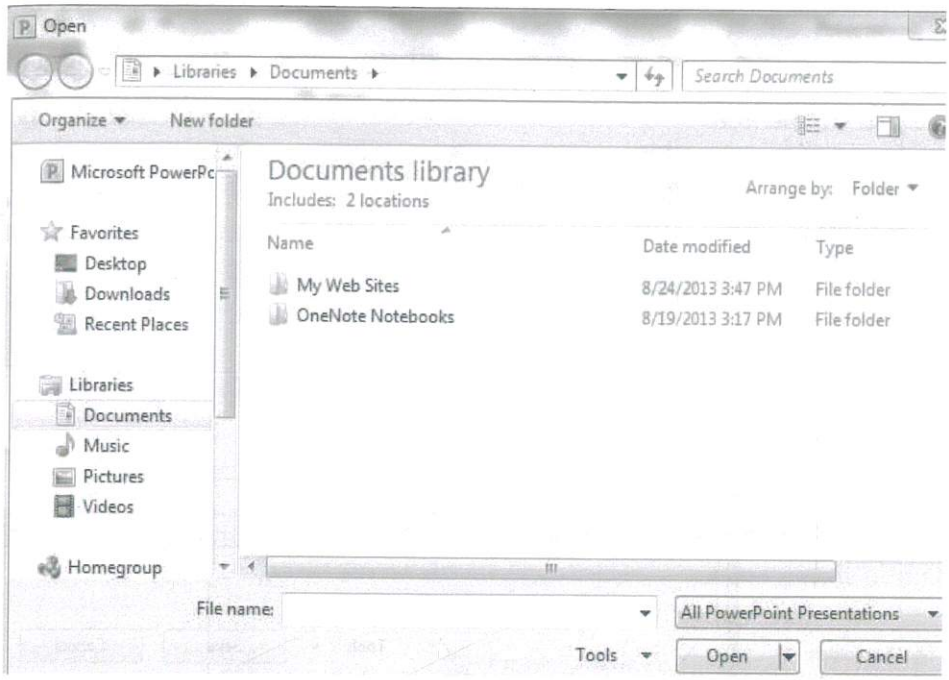
1. Go to the **File** tab which is present on the left hand side of the ribbon.
2. Go to the **Open** option of the **File** tab.

   The screenshot of an **Open** option is as shown:



3. As you click on the **Open** option, an **Open** dialog box appears. Choose the appropriate drive and folder from where you want to open the file.

The screenshot of an **Open** dialog box is as shown:



4. Choose the file which you want to open by writing its name in the **File name** text box.
5. Click on the **Open** option to open the file.

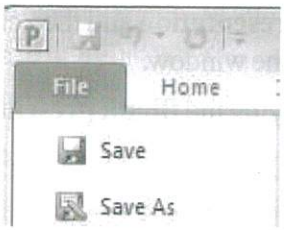
Saving a document

In PowerPoint 2010, by default, files are saved in .pptx format. In the previous version, files are saved in .ppt format. There are different ways of saving the files in your computer depending upon the requirements.

Steps for saving the presentation in PowerPoint are as follows:

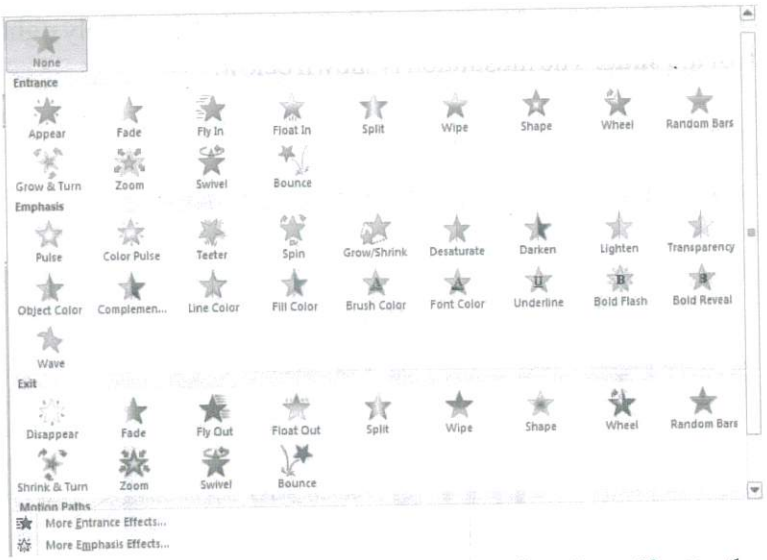
1. Go to the **File** tab which is present on the left hand side of the ribbon.
2. Go to the **Save As** option of the **File** tab on the left most side of the screen.

   The screenshot of **Save As** option in **File** tab is as shown:



3. As you click on the **Save As** option, a **Save As** dialog box appears. From the dialog box, you can choose the required drive or folder where you want to save the file.

The screenshot of **Animation** options is as shown:



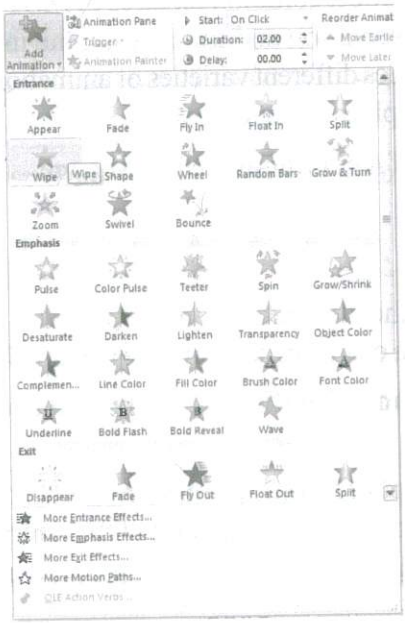
3. Click on **Effect Options** icon to apply an animation effect to the selected object.

   The screenshot of **Effect Options** icon of an **Animations** tab is as shown:

4. Click on the **Add Animation** icon present next to **Effect Options**. As you click on **Add Animation**, a pictorial view of all of the animation effects to animate text or graphics appears.

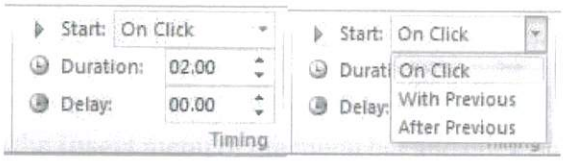
5. Choose the animation effect for adding it to the required object. The selected animation effect will be highlighted in golden color.

   The screenshot of **Add Animation** and selecting a specific animation effect is as shown:



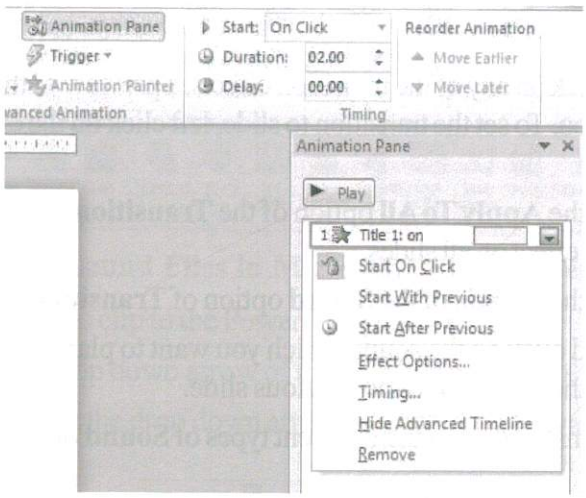
6. **Timing** group of **Animations** tab allows user to adjust the sequence and timing of selected animations. User can also adjust settings if an animation should be performed when the mouse is clicked or automatically.

   The screenshot of **Timing** group is as shown:



7. Click on the **Animation Pane**, it displays all the animations applied to each slide.

   The screenshot of **Animation Pane** is as shown:



8. After selecting all the animations as per the requirement, you can see the preview by clicking on the **Preview** icon available below the **File** menu.

   The screenshot of **Preview** option is as shown:

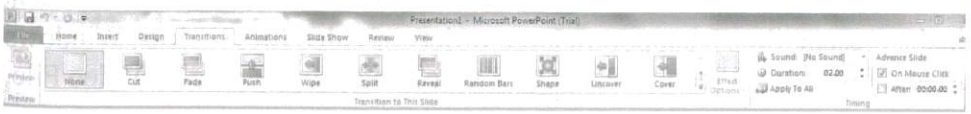
Transition Effects

Slide Transition is also an animation effect which is to define effects while proceeding from one slide to next slide during the slide show. It also includes adding sound effects. You can apply the different kinds of transition effects in slides of a presentation.

Steps to apply the transition effect are as follows:

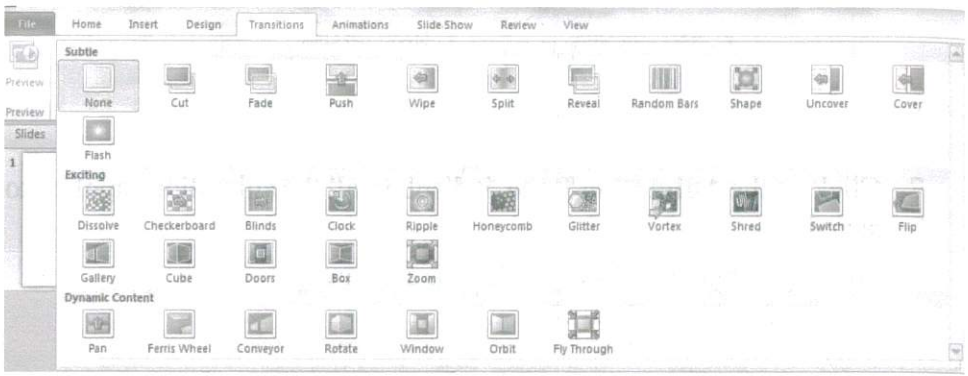
1. Click on the **Transitions** tab which is available on the Ribbon view.

   The screenshot of **Transitions** tab is as shown:



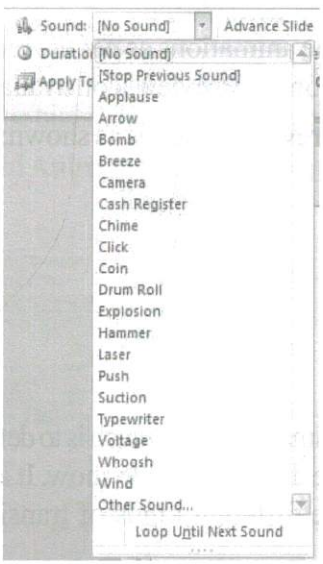
2. Click on the 'Up' and 'Down' arrow of **Transition to This Slide** group to choose a special effect that gets applied during the transition between the previous slide and next slide.

   The screenshot displaying all the **Transition Effects** is as shown:



3. As you click on any of the transition effects, a preview of the theme plays in front of you. To set the transition to slide, left click on the choice which you want.
4. Click on the **Apply To All** option of the **Transition** tab to apply the same transition effect on all slides.
5. Click on the list box of the **Sound** option of **Transition** tab.
6. Select and click on the sound which you want to play during the transition between the current and the previous slide.

   The screenshot displaying different types of **Sound** options is as shown:



7. After applying all the transitions you can also see the preview of a slide by clicking on the **Preview** option.

Adding Sound and Video in Slides

Microsoft Office PowerPoint 2010 allows its users to easily use audio-visual content in the presentation. It supports a large variety of video files such as, Windows Media File, MP4 Video, MPEG-2 TS Video and Window Media Video File,

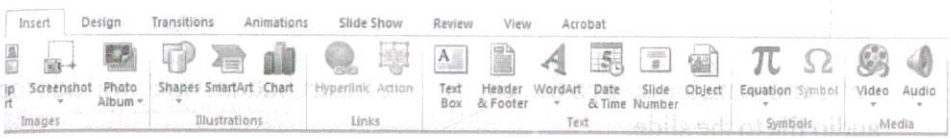
along with audio files such as ADTS Audio, AIFF audio file (aiff), AU audio file, MP3 and MP4 audio files.

Audio and video content can be added to Microsoft Office PowerPoint 2010, using the **Media Clips** Option under the **Insert Tab**. Thus, it is possible to insert sound, picture or media files in PowerPoint presentations or slides to make them more attractive and presentable.

Steps for adding audio or video clips in PowerPoint 2010 are as follows:

1. First go to the **Insert** menu of the menu bar and click on it.
2. When you click on it, you will discover the **Media** group containing **Video** and **Audio** options.
3. Now, click on the **Audio** or **Video** icon, as per your requirement.

   Screenshot displaying the **Audio** and **Video** icon, available under the **Media** group of the **Insert** tab is as shown:



- **Adding audio or sound Files in Microsoft Office PowerPoint 2010:**

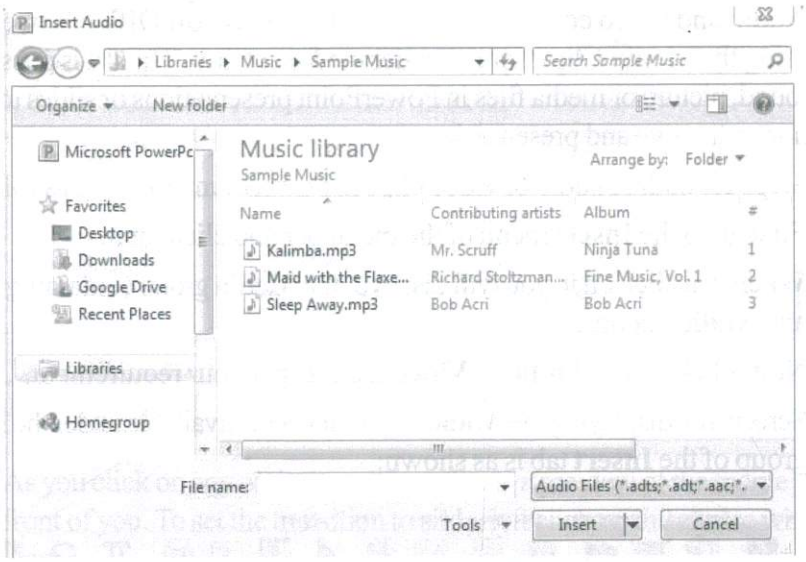
Steps for adding Audio clip to the PowerPoint file is as shown:

1. Click on the drop down arrow of the **Audio** icon under the **Media** group.
2. As you click on the drop down arrow, a list of options available under this icon appears.

   Screenshot displaying the **Audio** icon, visible after clicking the drop down arrow, is as shown:

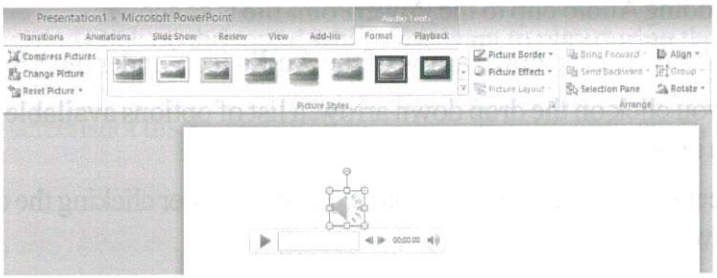
3. You can choose any of the three options to add audio from various sources, like from a previously saved file on your computer or from Clip Organizer.
4. Suppose you choose **Audio from File** option, then on clicking **Audio from File, Insert Audio** dialog box appears, showcasing a set of folders having the music or song files present on your system.
5. Now, navigate to the appropriate folder to use or place the desired audio file into the PowerPoint File
6. Click on **Libraries** and then double click on the **Music** library file or option. When you click on **Music**, the **Sample Music** folder appears. Next, double click on it.
7. After clicking on **Sample Music**, a window containing all the music files available in your system appears. Here, you can choose any media or sound file, you want to insert in your presentation.

Screenshot of the **Insert Audio** dialog box and files showcased under the **Music Folder**, after clicking on **Audio from File**, is as shown:



8. After choosing the desired file, click on the **Insert** button which will add the audio file to the slide.

   Screenshot of the slide after the **Audio File** has been added is as shown:



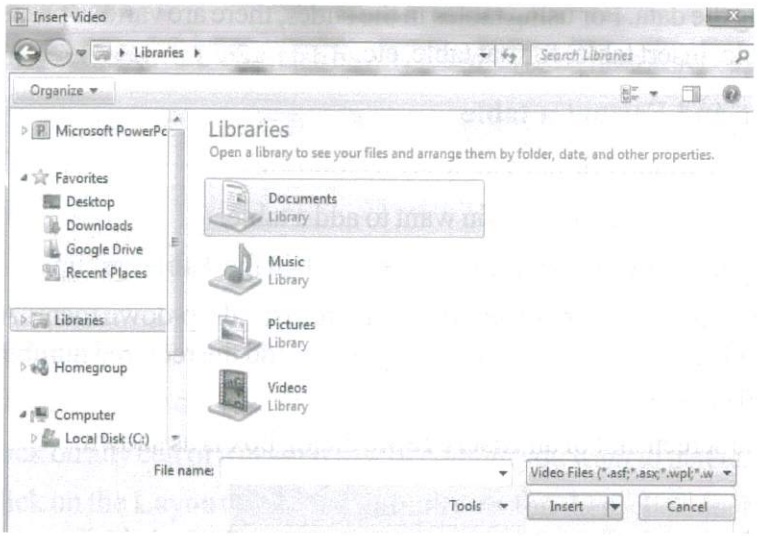
- **Adding Video Files in Microsoft Office PowerPoint 2010:**

1. Click on the drop down arrow of the **Video** icon of the **Media** group.
2. When you click on the drop down arrow, a list of available options appears.

   Screenshot displaying the **Audio** icon after clicking the drop down arrow is as shown:

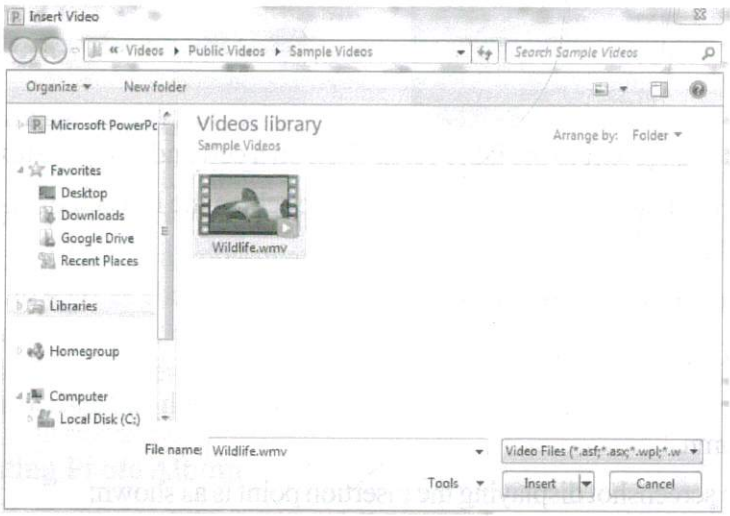
4. Now, you can choose one of the three options to add Video from various sources. Click on **Video from File** or to add from a website, click on **Video from Web Site**. To add from Clip Organizer, click on **Video from Clip Organizer**. Here, for example, let's click on **Video from File**. On clicking **Video from File**, **Insert Video** dialog box appears displaying the set of folders having all the music or song files present on your system.

Screenshot displaying the **Insert Video** dialog box containing the **Pictures** and **Videos** library is as shown:



5. Now, navigate to the appropriate folder to place the desired video file in the PowerPoint file.
6. Click on **Libraries** and then, double click on the **Video** or **Picture** library file.
7. When you click on the **Video** library, the **Sample Video** folder appears. Double click on it.
8. After clicking the **Sample Video**, a pop-up window containing all the video files available in your system appears, from where you can choose any media or video file to insert in your presentation.

   Screenshot of the video file present in the **Sample Video** folder, visible after clicking on **Video library**, is as shown:



9. After choosing the desired file, click on **Insert** button. This will add the video file to the slide.

Working with Tables and Pictures

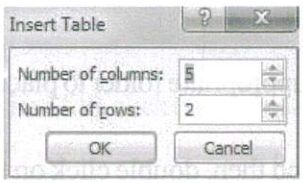
A Table is a representation in the form of rows and columns for managing and presenting the data. For using tables in the slides, there are various processes like create table, insert table, format table, etc.

- **Create and Format a table**

Steps to Create and Format a table are as follows:

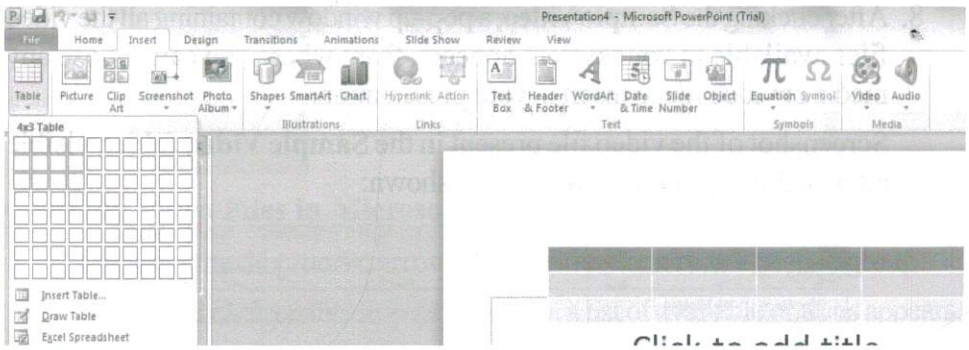
1. Select the slide where you want to add a table.
2. Select **Table** option from the **Insert** tab in the **Tables** group.
3. Click on the **Insert Table** command from the drop-down menu. An **Insert Table** dialog box appears where you can add the required number of rows and columns.

   The screenshot of an **Insert Table** dialog box is as shown:



4. You can also insert the table by selecting the required number of rows and columns on the Table grid of the drop-down menu.

   The screenshot of inserting a table using table grid is as shown:



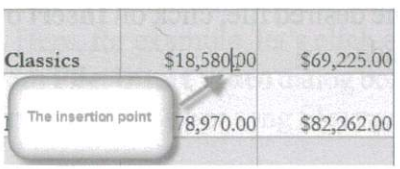
5. For adding text to the table cells, click on a cell and enter the text.
6. For adding a row at the end of a table, click on the last cell of last row and then press **TAB**.

- **For Adding a Column or a Row:**

Steps to add a column or a row are as follows:

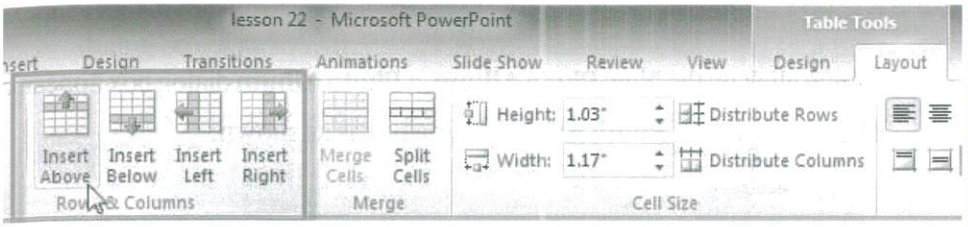
1. Click on the cell (insertion point) adjacent to which you wish to add row or column.

   The screenshot displaying the insertion point is as shown:



2. Use commands available in **Rows & Columns** group under **Layout** tab of **Table Tools** to insert rows or columns (above, below, left and right) of the selected cell.

   The screenshot of **Layout** tab having **Rows & Columns** group is as shown:

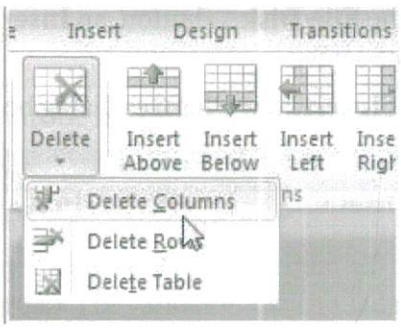


- **Deleting a Row or Column**

Steps to Delete a Row or Column are as follows:

1. Click on any cell of a desired row or column you want to delete.
2. Click on the **Layout** tab of the **Table Tools** and then, click on the **Delete** icon available in the **Rows & Columns** group.
3. As you click on the **Delete** icon, a drop-down menu containing three options such as **Delete Columns**, **Delete Rows** and **Delete Table** appears. You can select any one of them according to the requirement.

   The screenshot of **Delete** icon available in **Rows & Columns** group is as shown:



Creating Photo Album

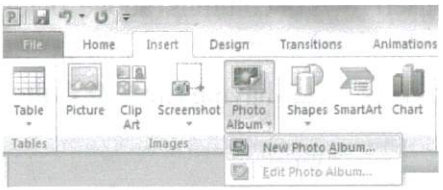
While creating the Photo Album in PowerPoint, you can use templates which are built in or create on your own. This feature allows you to add the pictures or photos of your choice in a presentation. Also, by exploring this feature of the MS PowerPoint, you can choose, rearrange and add text to the pictures. You can also add pictures from your drives to the Photo Album. Several effects like layouts, slide transitions and themes can be applied to the Photo Album. You can also add captions to the photos and frames around them.

For Creating Photo Album

Steps to create a Photo Album are as follows:

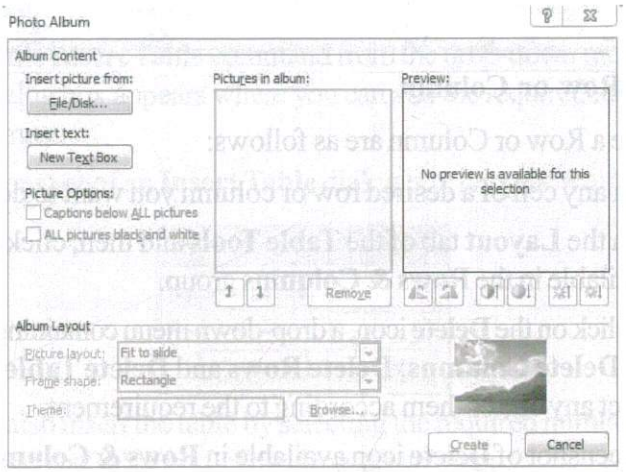
1. Select and click on the **Insert** tab available in the ribbon.
2. Click on the **Photo Album** option in the **Images** group and then select **New Photo Album** from the drop-down menu.

The screenshot of the **Photo Album** is as shown:



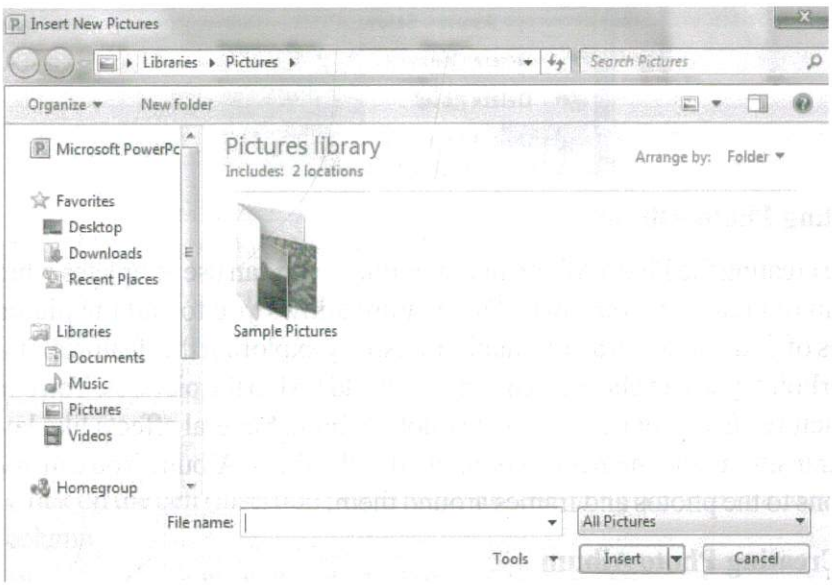
3. As you click on the **New Photo Album**, a **Photo Album** dialog box appears.

   The screenshot of **Photo Album** dialog box is as shown:



4. Click on the **File/Disk...** button of the **Photo Album** dialog box.
5. As you click on the **File/Disk...** button, an **Insert New Pictures** dialog box appears on the screen.

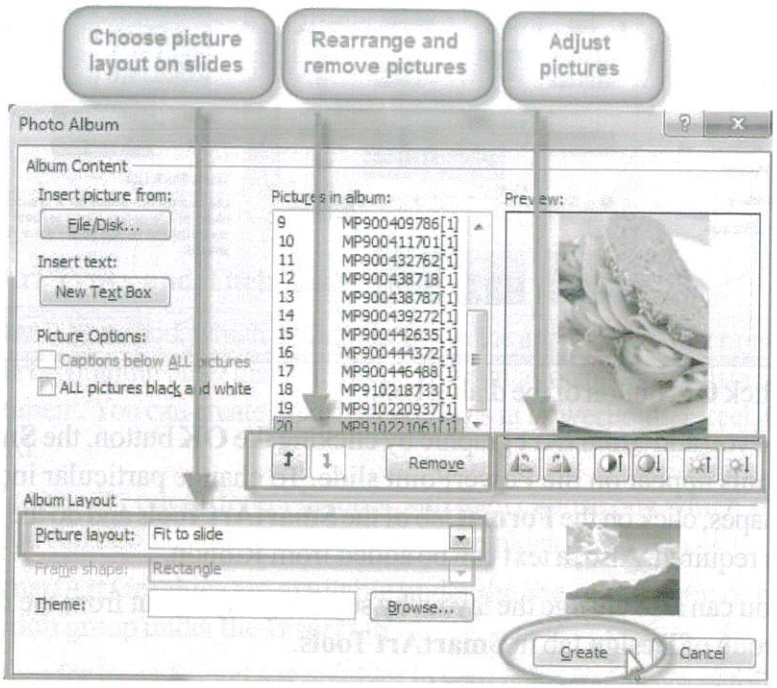
   The screenshot of **Insert New Pictures** dialog box is as shown:



6. Now, you can choose the desired images or photos from the corresponding drive by writing the name of the file in the **File name** textbox and then click on the **Insert** button.

7. A preview of the selected image appears inside the **Photo Album** dialog box. There are several options available for changing the layout, rotating the image, adjusting it as needed
8. Now, click on the **Create** button to insert images into the **Photo Album.**

   The screenshot of the **Picture layout** and **Theme** in the **Photo Album** dialog box is as shown:



9. A presentation with one image in each slide will be created. A title page is also automatically added in the presentation.

Working with SmartArt

A SmartArt can be easily inserted in MS PowerPoint 2010. SmartArt icon can be found in **Illustrations** group. The various graphics available in this option are All (basic block list, alternating hexagon, etc.), matrix, relationship, hierarchy, etc.

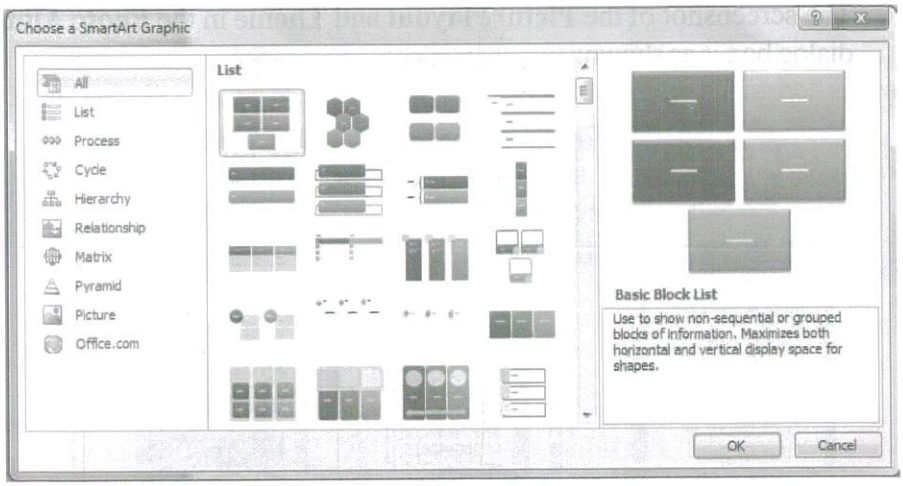
Steps to use the **SmartArt** icon are as follows:

1. Go to the **Insert** tab and then go to the **Illustrations** group.
2. Click on the **SmartArt** option of the **Illustrations** group.

   The screenshot of **SmartArt** option in **Illustrations** group is as shown:

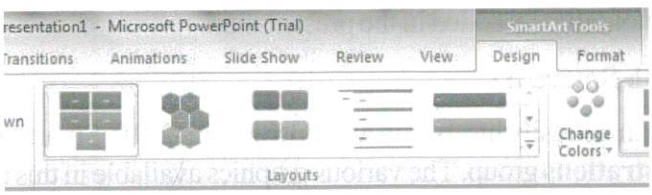
3. As you click on the **SmartArt**, a dialog box **Choose a SmartArt Graphic** appears having different categories such as **List, Relationship** and so on. You can choose any one of them according to the requirement.

   The screenshot of **Choose a SmartArt Graphic** dialog box is as shown:



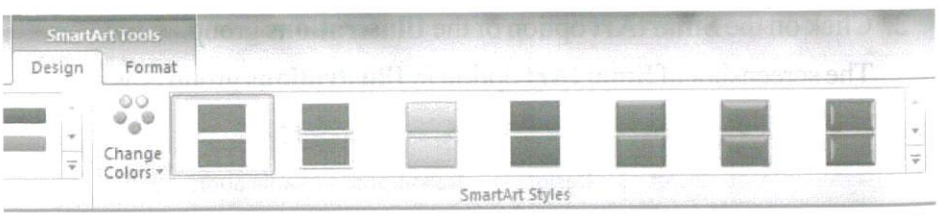
4. Click **OK** button of the dialog box.
5. As you add **SmartArt** graphic by clicking the **OK** button, the **SmartArt Tools** appear on the PowerPoint slide. To change particular individual shapes, click on the **Format** tab of the **SmartArt Tools** and do the changes as required. Also, a text can be added from Ribbon.
6. You can also change the layout by selecting any layout from the **Layouts** group of **Design** tab in **SmartArt Tools**.

   The screenshot of **Layouts** group is as shown:



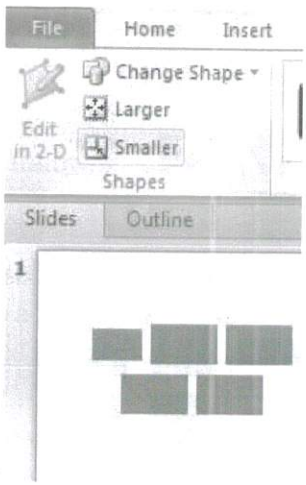
7. You can also change style, color and effects of the **SmartArt** Graphic by using the **SmartArt Styles** group.

   The screenshot of **SmartArt Styles** group is as shown:



8. You can change the size of the SmartArt shapes by clicking the **Smaller** and **Larger** icons from the **Shapes** group of the **Format** tab.

The screenshot of **Shapes** group is as shown:



SmartArt Types and Their Uses

SmartArt is a method, which helps to improve the artistic view of a presentation. **SmartArt** is nothing other than the visual representation of textual data presented in a document. You can create SmartArt graphics in PowerPoint, Excel, Outlook, and Word.

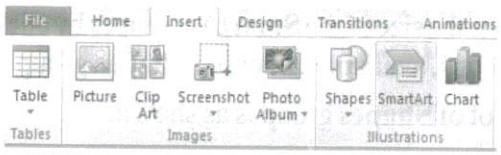
You can try out different layouts, and then choose one which suits your needs. You can choose among nine SmartArt graphics.

SmartArt Graphics are available under the **SmartArt** icon or button of **Illustration** group under the **Insert** tab.

Steps for using **SmartArt** graphics in your presentation are as follows:

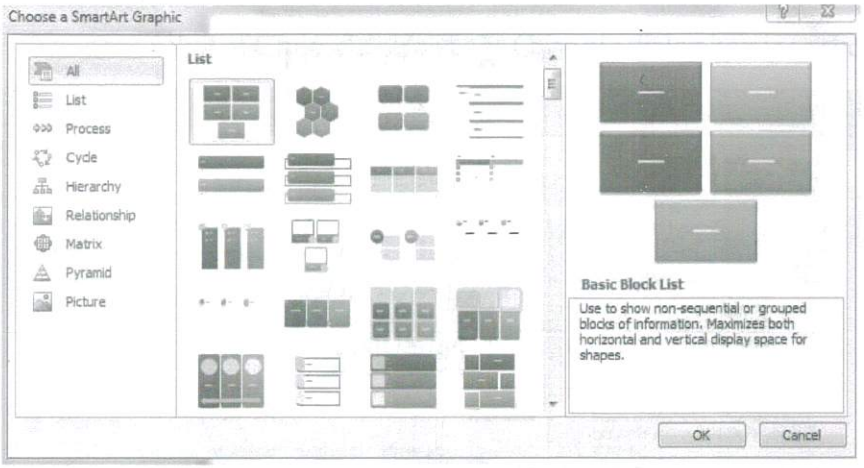
1. Go to the **Insert** tab of the menu bar and click on it.
2. When you click on it, the **Illustration** group will open displaying three icons or buttons, namely **Shapes**, **SmartArt** and **Chart**,

   Screenshot displaying the **SmartArt** icon in the **Illustrations** group is as shown:



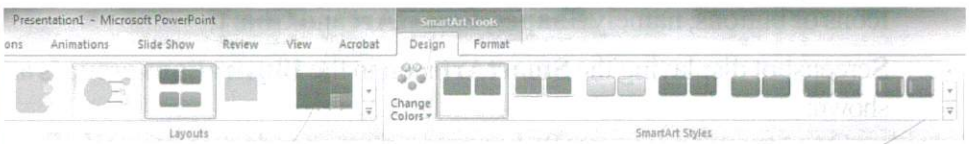
3. Now, as you click on the **SmartArt** icon, a new window or dialog box with the caption **Choose a SmartArt Graphic** will appear. This window contains several different categories or layouts of graphics such as **List**, **Relationship**, etc. You can choose any one of them, as you see fit.

Screenshot displaying the **Choose a SmartArt Graphic** dialog box is as shown:



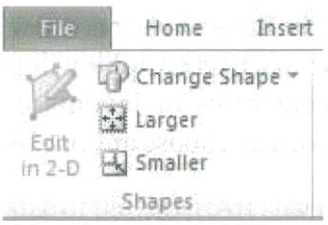
4. Choose the desired type and layout and click on the **OK** button.
5. When you click on the **OK** button, the selected **SmartArt Graphic layout** will be added to your presentation file.
6. Also, the **Design** tab of the menu bar will automatically appear, displaying the **Layouts** group and **SmartArt Styles** group. The layout of the graphic can be changed anytime by selecting a different layout from the **Layouts** group under **Design** tab in **SmartArt Tools**.
7. You can also change individual shapes by clicking on **Format** tab of the **SmartArt Tools** and making the required changes. Text can also be added from Ribbon.

   The screenshot displaying the **Layouts** group and **SmartArt Styles** group of the **Design** tab is as shown:



8. You can change the size of the **SmartArt** shapes by clicking on the **Smaller** and **Larger** icons, available under the **Shapes** group of the **Format** tab.

   The screenshot of **Shapes** group is as shown:



- **Uses of different SmartArt Graphics or Layouts:**

SmartArt Graphics represent information and ideas in visual form. It is chiefly designed for expressing concepts or ideas in a much more attractive and presentable way, as opposed to presenting the content solely in text format. In Microsoft

PowerPoint 2010, the **eight categories of SmartArt Graphics** enable the user to access or insert all the layout types. These graphics play a key role in providing a new shape and style to your content. Further, they enhance the versatility of your document.

Some of the frequently used **SmartArt Graphics**, their purpose and the advantages they have are as follows:

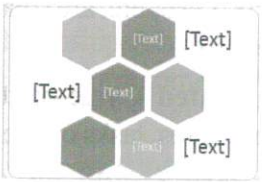
1. List

This type of layout can be used for data written in the form of a list. It transforms the bulleted list or text into a **SmartArt** Shape or Graphic. The shapes can be colored, resized and animated in order to highlight and emphasize the importance of your main points.

The layouts that belong to this group, do not present sequential information and thus, they do not have arrows for indicating the flow.

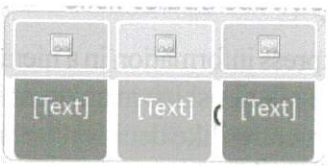
For example: Basic Block List, Alternating Hexagons, Picture Caption List, Table Hierarchy, Stacked List, Pie Process, etc. are examples of **Layouts** under the **List** category.

Screenshot displaying the pattern under **Alternating Hexagons** type of **List** is as shown:



This type of layout is used for representing content and ideas, as an interconnected series. Using this shape, **Text** appears in two levels. This implies that text is expressed inside the hexagons as well as outside the hexagons. Also, a couple of **List** layouts allow you to express your data using pictures. So, you can add pictures along with the text to highlight important information. **For Example: Horizontal Picture List** of the **List** group shows data in a non-sequential form and includes top shapes for inserting in pictures.

Screenshot displaying the **Horizontal Picture List** with two shapes is as shown:



2. Process:

Process layout is used for expressing data having a directional or sequential flow. It is used to illustrate the sequential steps needed to complete a task or to depict phases involved in development of a product.

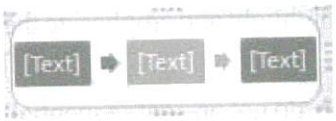
Process layouts can be used as horizontal steps, vertical steps, circular bending processes, etc.

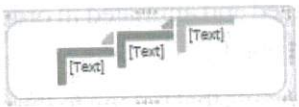
For example: Step Up Process, Ascent process, Chevron List, Segmented Process, Arrow Ribbon, Equation are some of the types of Layouts under the **Process** category.

Basic TimeLine Layout can be used to represent the sequence or flow of steps in case of any work, event, task or design procedure.

Step up Process is used to express text and present the information in an ascending or increasing manner.

Screenshots displaying the pattern or shape of the **Basic TimeLine** and **Step up** type of **Process** are as shown:





3. Cycle:

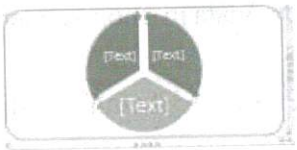
This type of **Smart Art** graphic layout is used to represent a repetitive or circular process such as Season cycles, Product development cycles, various life cycles, Website publishing cycle and many more. In these layouts, there are no defined or fixed beginning and ending points.

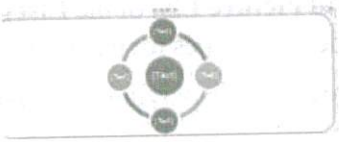
For example: Basic cycle, Text cycle, Block cycle, Segmented cycle, Basic Pie, Radial cycle, Cycle Matrix, Gear, etc. are some of the examples or types of Layouts under the **Cycle** category.

Basic Cycle and **Segmented Cycle** patterns or shapes are used for denoting the progression of processes, tasks or events, in circular flow.

Radial Cycle is used to show how the outer pieces of information or data connect to the central data and what the surrounding shapes are contributing to the central hub.

Screenshots displaying the **Segmented Cycle** and **Radial Cycle SmartArt Graphic** are as shown:





4. Hierarchy:

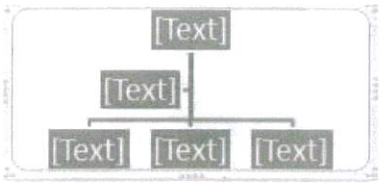
Hierarchy type is used to express information in a hierarchical manner. It basically denotes and emphasizes the relationships in an organization. Hierarchy can also be used to represent tree structures like decision trees, binary trees, B-trees. It is mostly used in case of organization charts, related to companies or employment.

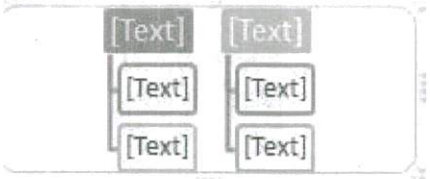
Hierarchy Type is used to show the various levels of organizations and depicting the sequence of steps to be followed, for the purpose of reporting and handling the employment system.

For Example: Organization Chart, Hierarchy, Labelled Hierarchy, Horizontal Hierarchy, Hierarchy List and Lined list are some of the types of Layouts under the **Hierarchy** category.

NOTES

Screenshots displaying the **Organization Chart** and **Hierarchy List** are as shown:





Organization Chart is mainly used for expressing the relationship among the various levels of the organization or company. Also, **Hierarchy List** shown in the second screenshot is used for denoting and representing the relationship and flow of information in a collective manner, as groups.

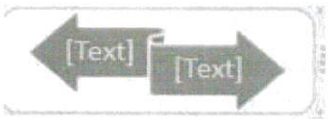
5. Relationship:

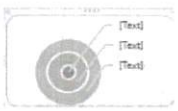
This layout is used to express or denote non-progressive and non-hierarchical relationships. **Relationship** layout can be used to show conceptual relationships such as overlapping between two or more sets of things. Venn diagrams, showing the overlapping areas at the centre of intersection, are a good example of the **Relationship SmartArt Graphics**.

Thus, this type of layout is used for illustrating connections and depicting how parts or pieces of information are related to the whole.

For example: Circle relationship, Arrow Ribbon, Basic Venn, Basic Target, Radial cluster, and Diverging Radial are some of the common layouts under the **Relationship** category.

Screenshots displaying **Arrow Ribbon** and **Basic Target Relationship** are as shown:





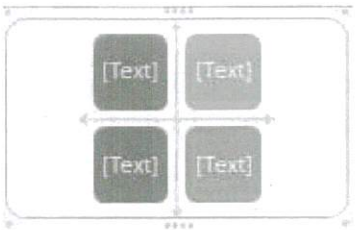
Arrow Ribbon (displayed in the first screenshot) is used for denoting concepts either as related or contradicting. **Basic Target** layout (shown in the second screenshot) is used to show gradations or containment, while the **Basic Radial** layout is used to collectively highlight processes in order to merge various concepts into a single central idea.

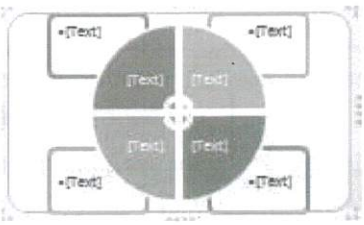
6. Matrix:

Matrix layout is used to represent the relationship between pieces of information or data, and express this information as a collective unit called matrix. It mainly classifies or expresses information in two dimensional forms.

For example: Basic Matrix, Titled matrix, Grid Matrix and Cycle Matrix are some of the popular layouts under the **Matrix** category.

Screenshots displaying the **Grid** matrix and **Cycle** Matrix are as shown:





In the first screenshot of **Grid** layout, the four lines showing the axes of level1 data appear in quadrants. The concepts are placed along the two axes.

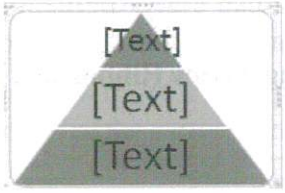
In **Cycle** matrix, first four lines of level 1 are shown in the form of a Pie and a rectangular shape is used for showing level 2 data.

7. Pyramid:

It is used to show hierarchical or proportional relationships, with largest component being placed at one end and the smallest component at the other end. Thus, all the patterns that belong to this category have an upwardly pointing shape. This layout is basically used for expressing information or relationships in two approaches, either top to down or bottom to up.

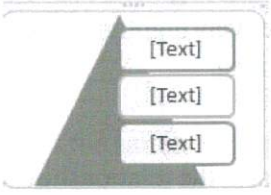
For example: Basic Pyramid, Inverted Pyramid, Pyramid List and Segmented Pyramid are some of the popular layouts under the **Pyramid** category.

Screenshot displaying the **Basic Pyramid** is as shown:



Another type or layout of the **Pyramid** category known as **Pyramid List**, can be used to write text in rectangular boxes provided on top of the pyramid background.

Screenshot displaying the shape of the **Pyramid List** is as shown:

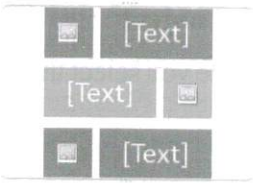


8. Picture:

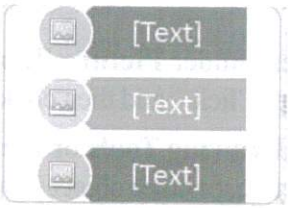
Picture layout is used for representing text and information using pictures. It gives your presentation an authentic touch and makes it more interactive, as well as attractive.

For example: Accented Picture, Alternating Picture Blocks, Bubble Picture List, Captioned Pictures, Snapshot Picture List, Vertical Picture List and Spiral Picture are some of the widely used types of Pyramid category layouts.

Screenshot displaying the **Alternating Picture Blocks** is as shown:



Screenshot displaying **Vertical Picture Accent List** layout of **Picture** category is as shown:



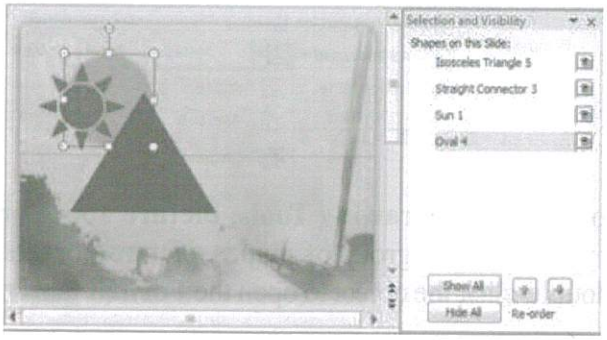
This layout is used for denoting information in non-sequential form by grouping blocks. It also contains circles attached with text blocks, for attaching and showing the pictures.

2.4.2 Working with Objects

Selecting objects

On the **Home** tab, in the **Editing** group, click **Select** and do one of the following:

- To select all of the objects and placeholders on the slide, click **Select All**.
- To select objects that are hidden, stacked, or behind text, click **Select Objects**, and then draw a box over the objects.
- To open the selection pane, where you can select, multi-select, show, hide, or change the order of objects, click **Selection Pane**, and then click the options that you want.



Grouping, ungrouping and regrouping objects

Grouping shapes, pictures or object

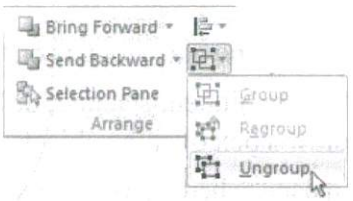
1. Press and hold CTRL while you select the shapes, pictures, or objects that you want to group.
2. Do one of the following:
   - To group shapes and other objects: under **Drawing Tools**, on the **Format** tab, in the **Arrange** group, Click , and then click **Group** .
   - To group pictures: under **Picture Tools**, on the **Format** tab, in the **Arrange** group, Click , and then click **Group**.

If you do not see the **Drawing Tools** or **Picture Tools** tabs, make sure that you selected a shape, picture, or other object. You might have to double-click the object to open the **Format** tab.

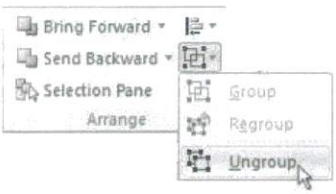
Ungrouping shapes, pictures or object

To ungroup a group of shapes, pictures, or other objects (for example, if you want to move a group but leave one shape behind or make extensive changes to one shape without changing the other shapes), do the following:

1. Select the group that you want to ungroup.
2. Do one of the following:
   - To ungroup shapes or other objects, under **Drawing Tools**, on the **Format** tab, in the **Arrange** group, click **Group** , and then Click **Ungroup**.



   - To ungroup pictures, under **Picture Tools**, on the **Format** tab, in the **Arrange** group, Click , and then click **Ungroup**.

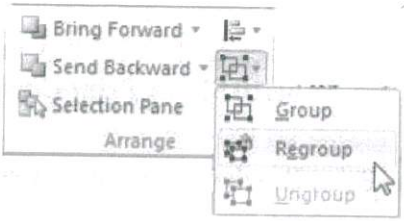


If you do not see the **Drawing Tools**, **Picture Tools**, or **Format** tabs, make sure that you selected a group of shapes, pictures, or other objects. You might have to double-click the object to open the **Format** tab.

Regrouping shapes, pictures or object

1. Select any one of the shapes or objects that were previously in a group.
2. Do one of the following:

- To regroup shapes and objects: under **Drawing Tools**, on the **Format** tab, in the **Arrange** group, click , and then click **Regroup**.
- To regroup pictures: under **Picture Tools**, on the **Format** tab, in the **Arrange** group, click , and then click **Regroup**.

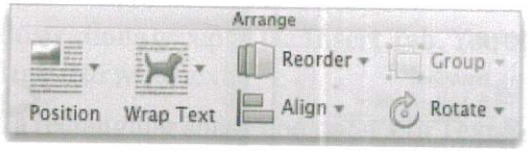


If you do not see the **Drawing Tools**, **Picture Tools**, or **Format** tabs, make sure that you selected a group of shapes, pictures, or other objects. You might have to double-click the object to open the **Format** tab.

Aligning object on a slide

Follow the steps given below to align object on a slide.

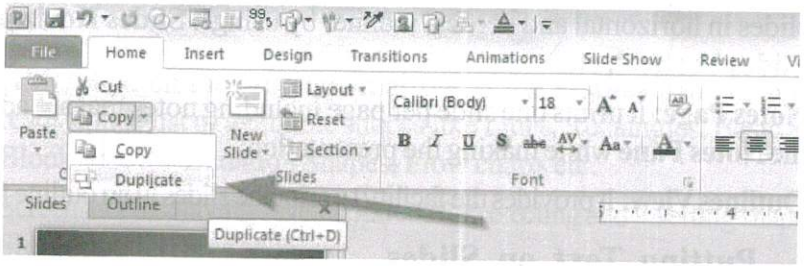
1. Hold down Shift , click the objects that you want to align, and then click the **Format** tab.
2. Click **Arrange** > **Align** > **Align to Slide**.



3. Click **Arrange** > **Align**, and then click the alignment that you want.

Cut, Copy, Paste and Duplicating an object

You can cut, copy, paste and duplicate an object in a slide using the illustration given below. In case of duplicating an object, Click to select the object that you want to **duplicate**. Hover over the object with your mouse and press the CTRL key until you see the plus symbol next to the arrow. While still pressing the CTRL key, click and drag the object to the new location.



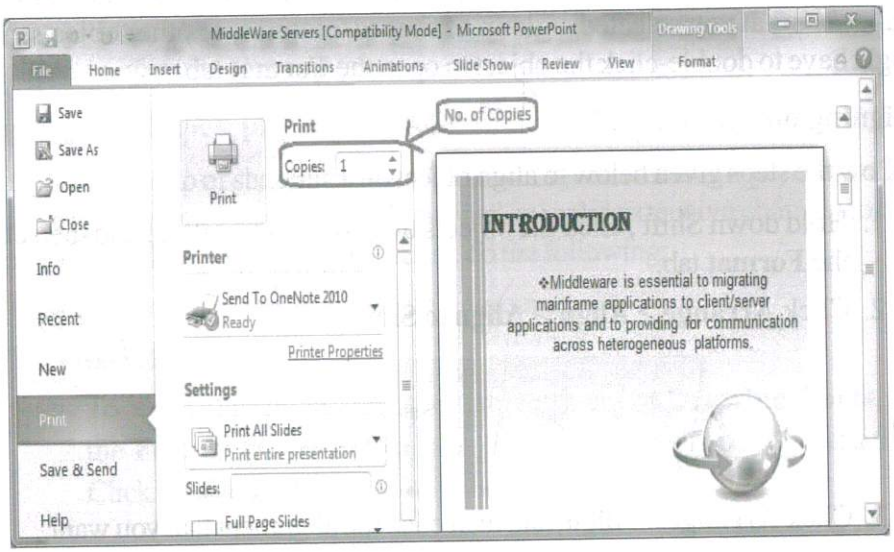
2.4.3 Printing Slides

You can modify the common print settings by using the drop-down menus. The print previews are automatically adjusted to allow you to see how the pages will appear before actually printing them.

Steps to print the slides are as follows:

1. Select the **File** tab in the Ribbon.
2. Select and click on the **Print** option. Then, fill the number of copies required in the **Copies** drop-down box.
3. As you click on the **Print** option, **Print Preview** appears on the right side of the PowerPoint window.
4. Click on the **Print All Slides** drop-down box in the **Settings** group to select the options like **Print All Slides, Print Current Slide**, and **Custom Range** of slides.
5. After checking the **Print Preview**, click on the **Print** button.

The screenshot of printing the presentation is as shown:



- **Print Layout**

There are many options to print the slides in different formats. These options are available in print layout tab. The options in Print Layout are as follows:

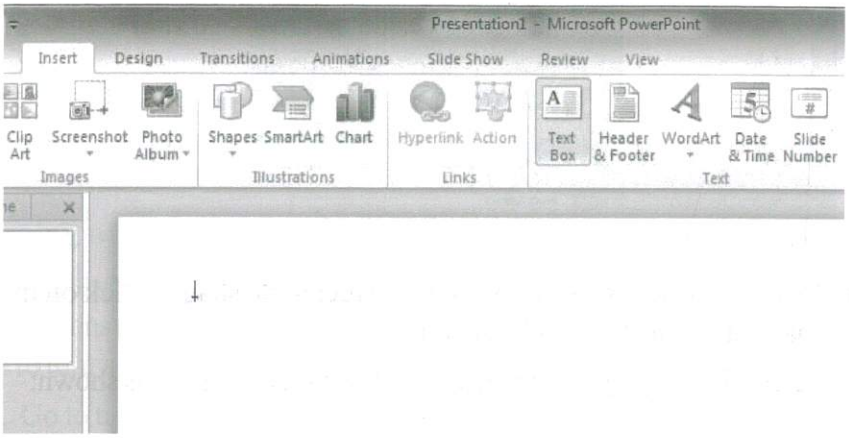
- **Full Page Slides:** It prints one slide on a full page.
- **Handouts:** There are various options available in the **Handouts** group. You can choose any one of them like **1 Slide, 2 Slides**. Also, you can print slides in horizontal and vertical manner by using **4 Slides Horizontal, 4 Slides Vertical,** etc.
- **Notes Page:** It prints one slide per page including notes that are added in the **Notes Pane** while making the presentation.
- **Outlines View:** It provides the facility to print the slides in an outline format.

2.4.4 Putting Text on Slides

To add text anywhere on slides, follow the steps given below.

1. Click on Text box command in the Text group that is available in the Insert menu.

2. Click and hold down the left mouse button while you drag the mouse. Release the mouse button when the size of box is as per your text size.
3. Click inside the text box and start typing.



NOTES

Using a Shape as a Text Box / Typing Text in Shapes

Microsoft Office PowerPoint 2010 allows its users to use **Shapes** as **Text Boxes,** which implies that you can add a **Shape** to your slide and then you can use it as a **Text Box** to write text inside it, making presentations more beautiful and informative.

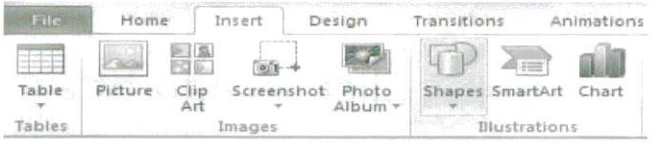
- **Turning a Shape into a Text Box:**

Shapes can be added to Microsoft Office PowerPoint 2010, using the **Shapes** option under the **Illustrations** group of the **Insert Tab**. You can insert any shape of your choice and use it to write text.

Steps to add a rectangular shape and use it as a **Text Box** are as follows:

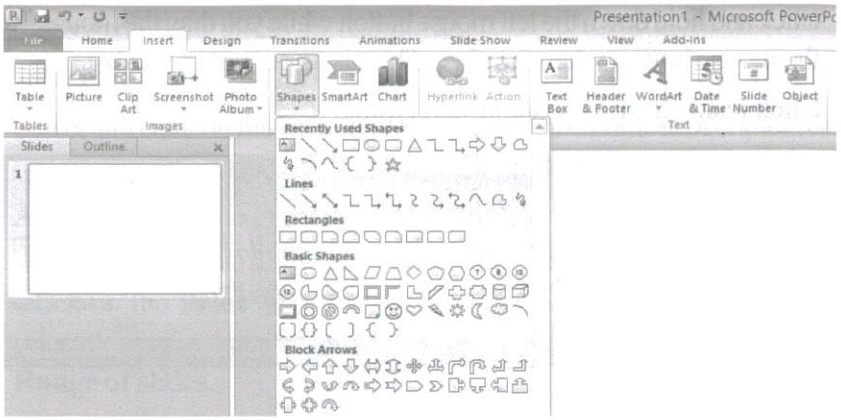
1. First go to the **Insert** menu of the menu bar and click on it.
2. When you click on the **Insert** tab, you will find **Illustrations** group containing three options namely, **Shapes**, **SmartArt** and **Chart**.

   Screenshot displaying **Shapes** under the **Illustrations** group of the **Insert** tab is as shown:



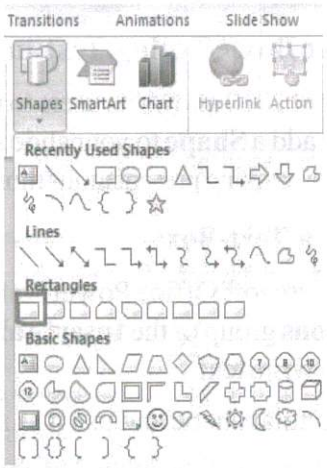
3. Now, click on the drop down arrow of the **Shapes** icon, to select the ready-made list of available shapes like Lines, Rectangles, Basic Shapes, Block Arrows, Equation Shapes, Flow charts etc.

   Screenshot displaying several options for selecting and inserting shapes from **Shapes** option is as shown:



4. Now, suppose you want to insert the rectangle shape. Click on the first shape under the Rectangles section.

   Screenshot displaying the selection of rectangle shape is as shown:

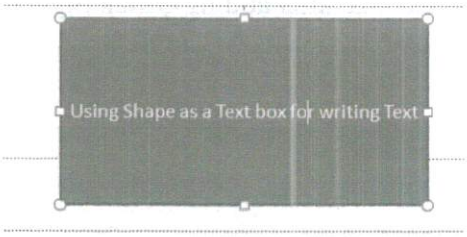


5. Now, after selecting the desired rectangular shape, drag the cursor and click on the area where you want to create your rectangle. Move the cursor away to create the rectangle.

   Screenshot displaying the rectangle inserted into the PowerPoint file is as shown:

6. Now, as the rectangle is created and inserted, just click on the Rectangle and wait for it to show a blinking cursor in the middle. This cursor will allow you to enter text.
7. Enter the text in the **Rectangle** and press **Enter**. Thus, we see how, Microsoft PowerPoint 2010 provides us the facility of turning any shape into a text box.

Screenshot of the **Rectangle Shape** seen in the PowerPoint slide, after entering the text is as shown:

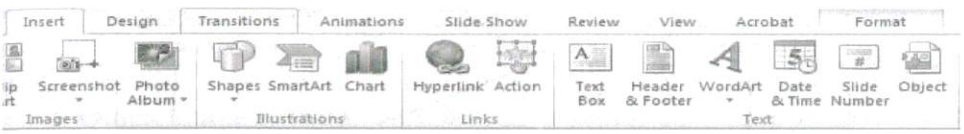


- **Turning a Text Box into a Shape:**

It is also possible to convert the text box into a shape and apply various **Quick Styles** options to it, in order to resize, colour and modify according to your choice. Steps to turn a text box into a shape are as follows:

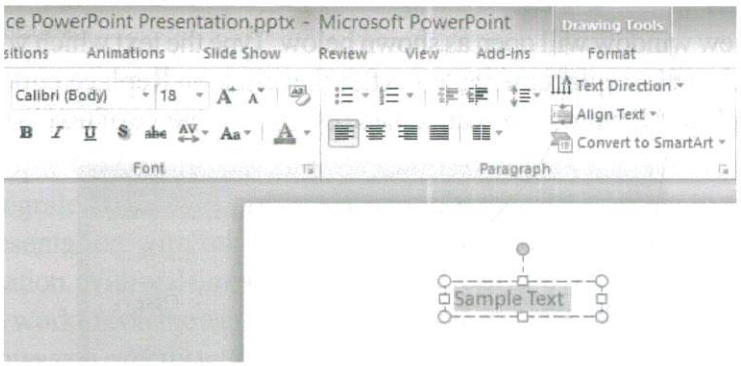
1. Go to the **Insert** tab of the ribbon view and click on the **Text Box** icon of the **Text** group.

   Screenshot displaying the **Text Box** icon, available in the **Text** group of the **Insert** tab is as shown:



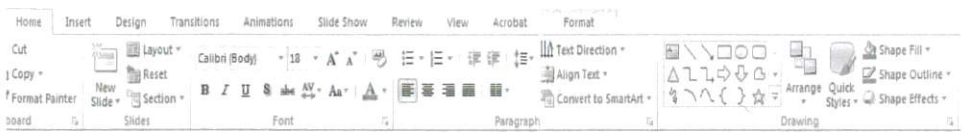
2. When you click on the **Text Box,** the shape of the cursor on the screen changes.
3. Now, click on the desired location and drag the cursor to insert a text box.

   Screenshot of a **Text Box** with sample text is as shown:



4. Now, go to the **Home** tab, and use the shape styling options of the **Drawing** group to use this text box as a shape.

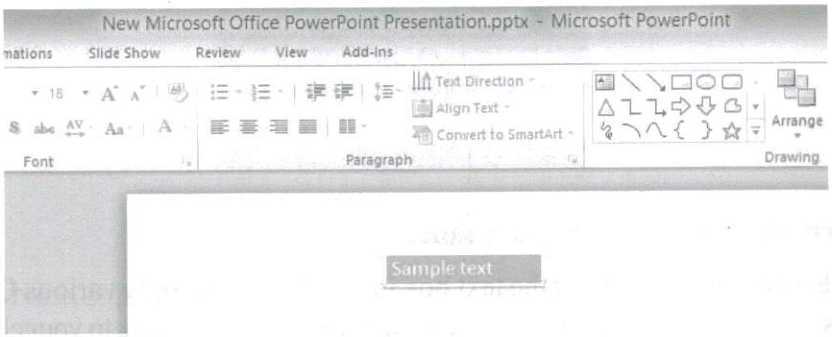
   Screenshot of the **Drawing** group of the **Home** tab is as shown:



NOTES

5. Choose from the **Quick Styles**, **Shape fill**, **Shape Outline** or **Shape Effects** to add a shape effect.

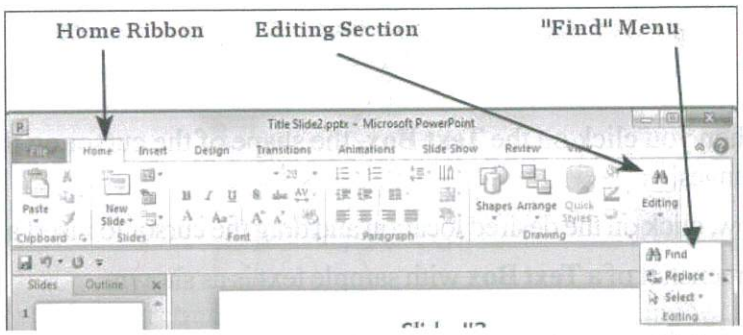
   Screenshot of a text box, after adding **Quick Style** into it, is as shown:



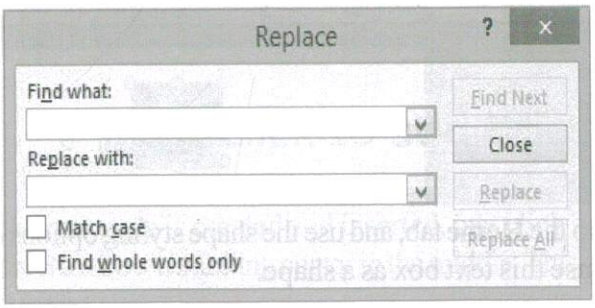
Finding and Replacing Text

To find and replace the text in slides, follow the steps given below.

1. Click on Home tab.
2. Go to the editing group where you will get Find and replace button. Click on it.



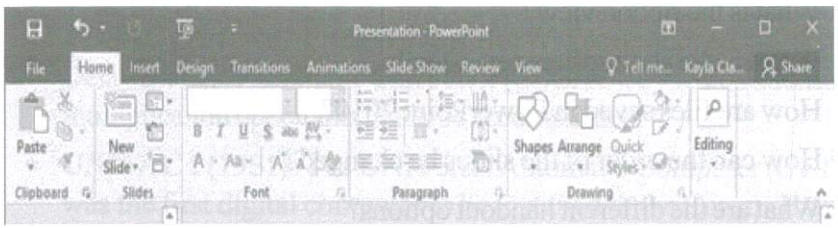
3. A new window will open as shown below. Type the text which you want to find and its replacement also. After that click on Replace button. Using Replace All button, you can replace every occurrence of text in the slide.



NOTES

New Features in PowerPoint 2016/ Difference between PowerPoint 2010 and 2016

PowerPoint 2016 is not much different from PowerPoint 2013 or 2010. Here also, all the menu items and often-used features are the same. The screenshot of ribbon interface is given below.



Although there aren't any dramatic changes, the latest version, PowerPoint 2016, brings some new enhancements to this top presentation programme, such as:

- **PowerPoint Designer:** With the new PowerPoint Designer, as soon as you insert an image, the ***Design Ideas*** panel opens on the right, offering several layout options for the graphical design of the current slide.
- **Morph Transition:** PowerPoint 2016 adds a brand new transition type called ***Morph***. This transition can help you make smooth animations, transitions, and object movements across the slides in your presentation.
- **Quick Shape Format:** Draw a shape on a slide and you'll see an increase to the number of "preset" styles available, another enhancement in PowerPoint 2016.
- **Six New Chart Types:** Microsoft Office 2016 has six new charts to show off your work in PowerPoint, Excel, and Word. New chart types include Waterfall, Treemap, Histogram (including Pareto), Box and Whisker, and Sunburst.
- **Screen recording:** you can now include screen recordings in your PowerPoint presentations with just a few clicks.
- **Simple Collaboration and Sharing:** Collaboration is more and more integrated into Office 2016. Choose **Share** on the ribbon to share your presentation with others on SharePoint, OneDrive, or another online location. With real time co-authoring, you can now not only see when others are working on the same shared presentation but also see an indicator that shows you exactly what slides they're working on, and where in the slides they are making changes.
- **Improved Version History:** Now you can go to **File > History** to see a complete list of changes that have been made to your presentation and even access earlier versions. **Note:** This feature is only supported for files stored on OneDrive for Business or SharePoint.
- **Tell Me:** One of the other PowerPoint 2016 new features is the "Tell Me" help tool. Look at the right side of the PowerPoint 2016 Ribbon menu after the last tab, to see a light bulb that says "Tell me what you want to do." Just enter the words and phrases that describe the steps you want to do next and quickly get the features or actions you want to use.

NOTES

- **Smart Look Up:** The Smart Lookup feature, which is available in most of the Office 2016 programs, gives you access to quick searches from inside of PowerPoint 2016.

Check Your Progress

16. What is the ribbon view?
17. When is the slide sorter view used?
18. How are files saved in PowerPoint 2010?
19. How can the order of the slides be changed?
20. What are the different handout options?
21. State the option to group pictures.
22. What does using shapes as text boxes imply?
23. How can shapes be added to Power Point 2010?

2.5 INTRODUCTION TO COMPUTERS

History and Generations of Computers

The first mechanical adding machine was invented by Blaise Pascal in 1642. Later, in 1671, Baron Gottfried Wilhelm von Leibniz of Germany invented the first calculator. Around this time, Herman Hollerith came up with the concept of punched cards, which were extensively used as an input medium in mechanical adding machines.

Charles Babbage, a nineteenth-century professor at Cambridge University, is considered the father of the modern digital computer. During this period, mathematical and statistical tables were prepared by a group of clerks. Utmost care and precautions, however, could not eliminate human errors.

In 1842, Babbage came up with his new idea of the Analytical Engine, which was intended to be completely automatic. This machine was capable of performing basic arithmetic functions. But, these machines were difficult to manufacture because the precision engineering required to manufacture them was not available at that time.

The following is a brief description of the various generations of computers.

- **Mark I Computer (1937-44)**: This was the first fully automatic calculating machine designed by Howard A. Aiken and the design of which was based on the technique of punching card machinery. In this technique, both mechanical and electronic components were used.
- **Atanasoff-Berry Computer (1939-42)**: This computer was developed by Dr. John Atanasoff to solve certain mathematical equations. It used 45 vacuum tubes for internal logic and capacitors for storage.
- **ENIAC (1943-46)**: The Electronic Numerical Integrator And Computer (ENIAC) was the first electronic computer developed for military requirements and was used for many years to solve ballistic problems.

- **EDVAC (1946-52)**: One of the drawbacks of ENIAC was that its programs were wired on boards, which made it difficult to change them. To overcome the drawbacks of ENIAC, the Electronic Discrete Variable Automatic Computer (EDVAC) was designed. The basic idea behind this concept was that sequences of instructions could be stored in the memory of the computer for automatically directing the flow of operations.
- **EDSAC (1947-49)**: Professor Maurice Wilkes developed the Electronic Delay Storage Automatic Calculator (EDSAC), by which addition and multiplication operations could be accomplished.
- **UNIVAC I (1951)**: The UNIVersal Automatic Computer (UNIVAC) was the first digital computer to be installed in the Census Bureau in 1951 and was used continuously for 10 years. In 1952, International Business Machines (IBM) introduced the 701 commercial computers. These computers could be used for scientific and business purposes.

Computer Generations

Table 2.1 shows the various generations of computers.

Table 2.1 *Generations of Computer*

Generation	Time	Hardware	Software	Features	Examples
I	**1942-1955**	**Vacuum Tubes**	Machine Language (Binary Language)	High-speed electronic switching device; memory type was electromagnetic; bulky in size; generated a large amount of heat; frequent technical faults; required constant maintenance; used for scientific purposes; air-conditioning required	ENIAC, EDVAC, EDSAC, UNIVAC I
II	**1955-1964**	**Transistors**	High-level languages FORTRAN, COBOL, ALGOL, SNOBOL	Better electronic switching devices than vacuum tubes; made of germanium semiconductors; memory type was magnetic cores; powerful and more reliable; easy to handle; much smaller than vacuum tubes; generated less heat as compared to vacuum tubes; used for business and industries for commercial data processing; air-conditioning required	Livermore Atomic Research Computer (LARC), IBM
III	**1964-1975**	**Integrated Circuits (ICs)** made up of transistors, resistors and capacitors fixed on single silicon chip	High-level languages PL/1, PASCAL, BASIC, VISUAL BASIC, C, C++, C#, Java	ICs were smaller than transistors; consumed less power; dissipated less heat as compared to transistors; more reliable and faster than earlier generations; capable of performing about 1 million instructions per second; large storage capacity; used for both scientific and commercial purposes; air-conditioning required	Mainframe, Minicomputers
IV	**1975-1989**	**Microprocessor** made up of Large Scale Integration Circuits (LSI) and Very Large Scale Integration Circuits (VLSI)	Advanced Java (J2EE, JDO, JavaBeans), PHP, HTML, XML, SQL	Microprocessor had control on logical instructions and memory; semiconductor memories; personal computers were assembled; used in LAN and WAN to connect multiple computers at a time; used graphical user interface; smaller, more reliable and cheaper than third-generation computers; larger primary and secondary storage memories; had Computer Supported Cooperative Working (CSCW); air-conditioning not required	Personal Computers (PCs), LAN, WAN, CSCW
V	**1989-Present**	Ultra Scale Large Integration (USLI), Optical Disks	Artificial Intelligence, PROLOG, OPS5, Mercury	PCs were assembled – portable and non-portable, powerful desktop PCs and workstations; less prone to hardware failure; user-friendly features – Internet, e-mailing; air-conditioning not required	Portable PCs, Palmtop Computers, Laptop

Analog and Digital Computers

Computers are classified into three types:

- Digital computers
- Analog computers
- Hybrid computers

Digital Computers

Digital computers are commonly used for data processing and solving problems using programs. These operate by counting digits in the binary form and processing data in discrete form. Digital computers have large memories that enable them to store large quantities of data.

Analog Computers

Analog computers are generally used in industrial process controls and to measure physical quantities such as pressure, temperature and so on. These do not use binary digits for computation. They work on continuous electrical signal inputs and the output is displayed continuously. Its memory capacity is less and can perform only certain types of calculations. However, they are faster than digital computers. The accuracy of result obtained from an analog computer is about 99 per cent.

Hybrid Computers

Hybrid computers are the combination of digital and analog computers. They use the best features of digital and analog computers. They help the user to process both continuous and discrete data. Hybrid computers are generally used for weather forecasting and industrial process control.

2.5.1 Number System for Computers (Binary, Octal, Hexadecimal)

A number system that uses only two digits, 0 and 1 is called the binary number system. The binary number system is also called a base two system. The two symbols 0 and 1 are known as **bits** or binary digits.

The binary system groups numbers by two and by powers of two, shown in Figure 2.1. The word binary comes from a Latin word meaning two at a time.

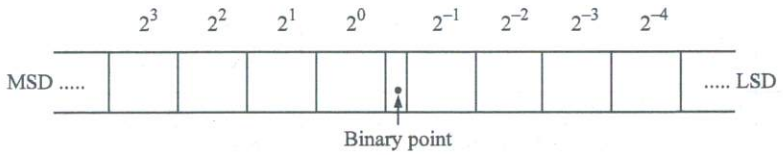


Fig. 2.1 *Binary Position Values as a Power of 2*

The weight or place value of each position can be expressed in terms of 2, and is represented as 2^0, 2^1, 2^2, etc. The least significant digit has a weight of 2^0 (= 1). The second position to the left of the least significant digit is multiplied by 2^1 (= 2). The third position has a weight equal to 2^2 (= 4). Thus, the weights are in the ascending powers of 2 or 1, 2, 4, 8, 16, 32, 64, 128, etc.

The numeral 10_{two} or 10_2 (one, zero, base two) stands for **two**, the base of the system.

In binary counting, single digits are used for **none** and **one**. Two-digit numbers are used for 10_{two} and 11_{two} [2 and 3 in decimal numerals]. For the next counting number, 100_{two} (4 in decimal numerals) three digits are necessary. After 111_{two} (7 in decimal numerals) four-digit numerals are used until 1111_{two} (15 in decimal numerals) is reached, and so on. In a binary numeral, every position has a value 2 times the value of the position to its right.

A binary number with 4 bits, is called a nibble and a binary number with 8 bits is known as a byte.

For example, the number 1011_2 actually stands for the following representation:

$$1011_2 = 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0$$
$$= 1 \times 8 + 0 \times 4 + 1 \times 2 + 1 \times 1$$
$$\therefore \quad 1011_2 = 8 + 0 + 2 + 1 = 11_{10}$$

In general,

$$[b_n, b_{n-1} \ldots b_2, b_1, b_0]_2 = b_n 2^n + b_{n-1} 2^{n-1} + \ldots + b_2 2^2 + b_1 2^1 + b_0 2^0$$

Similarly, the binary number 10101.011 can be written as,

1	0	1	0	1	.	0	1	1
2^4	2^3	2^2	2^1	2^0	.	2^{-1}	2^{-2}	2^{-3}
(MSD)						(LSD)		

$$\therefore \quad 10101.011_2 = 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$
$$+ 0 \times 2^{-1} + 1 \times 2^{-2} + 1 \times 2^{-3}$$
$$= 16 + 0 + 4 + 0 + 1 + 0 + 0.25 + 0.125 = 21.375_{10}$$

In each binary digit, the value increases in powers of two starting with 0 to the left of the binary point and decreases to the right of the binary point starting with power –1.

Binary Number System used in Digital Computers

The binary number system is used in digital computers because all electrical and electronic circuits can be made to respond to the two-state concept. A switch, for instance, can be either opened or closed, only two possible states exist. A transistor can be made to operate either in cut-off or saturation; a magnetic tape can be either magnetized or non-magnetized; a signal can be either HIGH or LOW; a punched tape can have a hole or no hole. In all of the above illustrations, each device is operated in any one of the two possible states and the intermediate condition does not exist. Thus, 0 can represent one of the states and 1 can represent the other. Hence, binary numbers are convenient to use in analysing or designing digital circuits.

Decimal Number System

The number system which utilizes ten distinct digits, i.e., 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 is known as decimal number system. It represents numbers in terms of groups of ten, as shown in Figure 2.2.

We would be forced to stop at 9 or to invent more symbols if it were not for the use of positional notation. It is necessary to learn only 10 basic numbers and positional notational system in order to count any desired figure.

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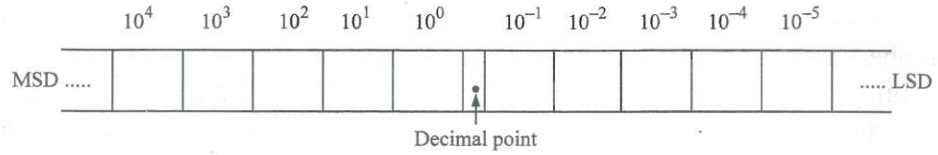

Fig. 2.2 Decimal Position Values as Powers of 10

The decimal number system has a base or radix of 10. Each of the ten decimal digits 0 through 9, has a place value or weight depending on its position. The weights are units, tens, hundreds and so on. The same can be written as the power of its base as 10^0, 10^1, 10^2, 10^3... etc. Thus, the number 1993 represents quantity equal to $1000 + 900 + 90 + 3$. Actually, this should be written as $\{1 \times 10^3 + 9 \times 10^2 + 9 \times 10^1 + 3 \times 10^0\}$. Hence, 1993 is the sum of all digits multiplied by their weights. Each position has a value 10 times greater than the position to its right.

For example, the number 379 actually stands for the following representation.

$$\begin{array}{lll} 100 & 10 & 1 \\ 10^2 & 10^1 & 10^0 \\ 3 & 7 & 9 \end{array}$$

$$3 \times 100 + 7 \times 10 + 9 \times 1$$

$$\therefore \quad 379_{10} = 3 \times 100 + 7 \times 10 + 9 \times 1$$

$$= 3 \times 10^2 + 7 \times 10^1 + 9 \times 10^0$$

In this example, 9 is the Least Significant Digit (LSD) and 3 is the Most Significant Digit (MSD).

Example 2.1: Write the number 1936.469 using decimal representation.

Solution: $1936.469_{10} = 1 \times 10^3 + 9 \times 10^2 + 3 \times 10^1 + 6 \times 10^0 + 4 \times 10^{-1} + 6 \times 10^{-2} + 9 \times 10^{-3}$

$$= 1000 + 900 + 30 + 6 + 0.4 + 0.06 + 0.009 = 1936.469$$

It is seen that powers are numbered to the left of the decimal point starting with 0 and to the right of the decimal point starting with –1.

The general rule for representing numbers in the decimal system by using positional notation is as follows:

$$a_n a_{n-1} \ldots a_2 a_1 a_0 = a_n 10^n + a_{n-1} 10^{n-1} + \ldots a_2 10^2 + a_1 10^1 + a_0 10^0$$

Where n is the number of digits to the left of the decimal point.

Octal and Hexadecimal Numbers

Octal Number System

The octal number system was used extensively by early minicomputers. However, for both large and small systems, it has largely been supplanted by the hexadecimal system. Sets of 3 bit binary numbers can be represented by octal numbers and this can conveniently be used for entire data in the computer.

A number system that uses eight digits, 0, 1, 2, 3, 4, 5, 6 and 7 is called an octal number system.

It has a base of **eight**. The digits, 0 through 7 have exactly the same physical meaning as decimal symbols. In this system, each digit has a weight corresponding to its position as shown below:

$$a_n 8^n + \ldots a_3 8^3 + a_2 8^2 + a_1 8^1 + a_{-1} 8^{-1} + a_{-2} 8^{-2} + \ldots + a_{-n} 8^{-n}$$

Octal Odometer

Octal odometer is a hypothetical device similar to the odometer of a car. Each display wheel of this odometer contains only eight digits (teeth), numbered 0 to 7. When a wheel turns from 7 back to 0 after one rotation, it sends a carry to the next higher wheel. Table 2.2 shows equivalent numbers in decimal, binary and octal systems.

Table 2.2 *Equivalent Numbers in Decimal, Binary and Octal Systems*

Decimal (Radix 10)	*Binary (Radix 2)*	*Octal (Radix 8)*
0	000 000	0
1	000 001	1
2	000 010	2
3	000 011	3
4	000 100	4
5	000 101	5
6	000 110	6
7	000 111	7
8	001 000	10
9	001 001	11
10	001 010	12
11	001 011	13
12	001 100	14
13	001 101	15
14	001 110	16
15	001 111	17
16	010 000	20

Consider an octal number $[567.3]_8$. It is pronounced as five, six, seven octal point three and not five hundred sixty seven point three. The co efficients of the integer part are $a_0 = 7$, $a_1 = 6$, $a_2 = 5$ and the co-efficient of the fractional part is $a_{-1} = 3$.

Hexadecimal Number System

The hexadecimal system groups numbers by sixteen and powers of sixteen. Hexadecimal numbers are used extensively in microprocessor work. Most minicomputers and microcomputers have their memories organized into sets of bytes, each consisting of eight binary digits. Each byte either is used as a single entity to represent a single alphanumeric character or broken into two 4 bit pieces. When the bytes are handled in two 4 bit pieces, the programmer is given the option of declaring each 4 bit character as a piece of a binary number or as two BCD numbers.

The hexadecimal number is formed from a binary number by grouping bits in groups of 4 bits each, starting at the binary point. This is a logical way of grouping, since computer words come in 8 bits, 16 bits, 32 bits and so on. In a group of 4 bits, the decimal numbers 0 to 15 can be represented as shown in Table 2.3.

The hexadecimal number system has a base of 16. Thus, it has 16 distinct digit symbols. It uses the digits 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 plus the letters A, B, C, D, E and F as 16 digit symbols. The relationship among octal, hexadecimal, and binary is shown in Table 2.3. Each hexadecimal number represents a group of four binary digits.

Table 2.3 Equivalent numbers in Decimal, Binary, Octal and Hexadecimal Number Systems

Decimal (Radix 10)	*Binary (Radix 2)*	*Octal (Radix 8)*	*Hexadecimal (Radix 16)*
0	0000	0	0
1	0001	1	1
2	0010	2	2
3	0011	3	3
4	0100	4	4
5	0101	5	5
6	0110	6	6
7	0111	7	7
8	1000	10	8
9	1001	11	9
10	1010	12	A
11	1011	13	B
12	1100	14	C
13	1101	15	D
14	1110	16	E
15	1111	17	F
16	0001 0000	20	10
17	0001 0001	21	11
18	0001 0010	22	12
19	0001 0011	23	13
20	0001 0100	24	14

Counting in Hexadecimal

When counting in **hex**, each digit can be incremented from 0 to F. Once it reaches *F*, the next count causes it to recycle to 0 and the next higher digit is incremented. This is illustrated in the following counting sequences: 0038, 0039, 003A, 003B, 003C, 003D, 003E, 003F, 0040; 06B8, 06B9, 06BA, 06BB, 06BC, 06BD, 06BE, 06BF, 06C0, 06C1..... and like that.

2.5.2 Data Representation and Coding Systems (BCD, EBCDIC, ASCII)

Character Representation

Binary data is not the only data handled by a computer. We also need to process alphanumeric data like alphabets (upper and lower case), digits (0 to 9) and special characters like + – * / ( ) space or blank, etc. These also must be internally represented as bits.

Table 2.4 BCD Equivalent of Decimal Digits

Decimal Number	Binary Equivalent
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001

Binary Coded Decimal

Binary Coded Decimal (BCD) is one of the early memory codes. It is based on the concept of converting each digit of a decimal number into its binary equivalent rather than converting the entire decimal value into a pure binary form. It further uses 4 digits to represent each of the digits. Table 2.4 shows the BCD equivalent of the decimal digits.

Converting 42_{10} into its BCD equivalent, would result in:

$$42_{10} = \underset{4}{0100} \quad \underset{2}{0010} \text{ or } 01000010 \text{ in BCD}$$

As seen, 4-bit BCD code can be used to represent decimal numbers only. Since 4 bits are insufficient to represent the various other characters used by the computer, instead of using only 4-bits (giving 16 possible combinations), computer designers commonly use 6 bits to represent characters in BCD code. In this, the 4 BCD numeric place positions are retained but two additional zone positions are added. With 6 bits, it is possible to represent 2^6 or 64 different characters. This is, therefore, sufficient to represent the decimal digits (10), alphabetic characters (26) and special characters (28).

Extended Binary Coded Decimal Interchange Code

The major drawback with the BCD code is that it allows only 64 different characters to be represented. This is not sufficient to provide for decimal numbers (10), lower-case letters (26), upper-case letters (26), and a fairly large number of special characters (28 plus).

The BCD code was, therefore, extended from a 6-bit to an 8-bit code. The added 2 bits are used as additional zone bits, expanding the zone bits to 4. This resulting code is called the Extended Binary Coded Decimal Interchange Code (EBCDIC). Using the EBCDIC it is possible to represent 2^8 or 256 characters. This takes care of the character requirement along with a large quantity of printable and several non-printable control characters (movement of the cursor on the screen, vertical spacing on printer, and so on.

Since EBCDIC is an 8-bit code, it can easily be divided into two 4-bit groups. Each of these groups can be represented by one hexadecimal digit. Thus, hexadecimal number system is used as a notation for memory dump by computers that use EBCDIC for internal representation of characters.

Developed by IBM, EBCDIC code is used in most IBM models and many other computers.

American Standard Code for Information Interchange

A computer code that is very widely used for data interchange is called the 'American Standard Code for Information Interchange' or ASCII. Several computer manufacturers have adopted it as their computers' internal code. ASCII code uses 7 digits to represent 128 characters. Now an advanced ASCII is used having 8-bit character representation code allowing for 256 different characters. This representation is being used in micro- computers.

Let us look at the encoding method. Table 2.5 shows the bit combinations required for each character.

Table 2.5 Bit Combinations

	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
00	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	TAB	LF	VT	FF	CR	SO	SI
10	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
20		!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
30	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
40	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
50	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
60	'	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
70	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL

Thus, to code a text string 'Hello.' in ASCII using hexadecimal digits:

H	e	l	l	o	.
48	65	6C	6C	6F	2E

The string is represented by the byte sequence 48 65 6C 6C 6F 2E.

Components of a Computer Memory

Memory in the computer system is required for storage and subsequent retrieval of instructions and data. We have learned that the Central Processing Unit (CPU) contains several registers for storing data and instructions. But these can store only a few bytes. If all the instructions and data being executed by the CPU resided in secondary storage (like magnetic tapes and disks), and was loaded into the registers of the CPU as the program execution proceeded, it would lead to the CPU being idle for most of the time. This is because the speed at which the CPU processes data is much higher than the speed at which data can be transferred from disks to registers. Every computer thus requires storage space where instructions and data of a program can reside temporarily when the program is being executed. This temporary storage area is built into the computer hardware and is known as the primary storage or the main memory. Devices that provide backup storage (like magnetic tapes and disks) are called secondary storage or auxiliary memory. Thus, a memory system can be considered to consist of three groups of memories:

- Internal processor memory consists of a small set of high-speed registers that are internal to a processor and are used as temporary locations where the actual processing is done.
- Primary storage or main memory is a large memory, which is fast, but not as fast as the internal processor memory. This memory communicates directly with the CPU and is mainly based on integrated circuits.
- Secondary storage or auxiliary memory or backing store is much larger in size than the main memory but is slower than the main memory. It typically stores all the system programs and other software.

Another type of memory that is increasingly being used in modern computers is called the cache memory. It is logically positioned between the internal memory

(registers) and the main memory. It stores and caches some of the content of the main memory that is currently used by the processor. Figure 2.3 shows the memory hierarchy.

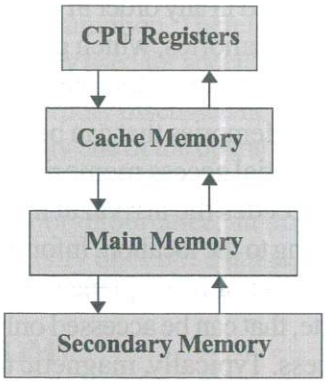

Fig. 2.3 The Memory Hierarchy

The total memory capacity of the computer can therefore be visualized as being a hierarchy of components. It consists of all storage devices employed in a computer system from the slow but high-capacity auxiliary memory to a relatively faster main memory, to an even smaller and faster cache memory accessible to high-speed processing logic. Thus, as one goes down in the hierarchy, the following conditions occur:

- Decreasing cost per bit
- Increasing capacity
- Increasing access time
- Decreasing frequency of access of the memory by the processor

Storage Evaluation Criteria

The most common properties used for characterizing and evaluating the storage unit of the computer system are as follows:

- **Storage capacity**: Represents the size of the memory. It is the amount of data that can be stored in the storage unit. Primary storage units have less storage capacity as compared to secondary storage units. While the capacity of internal memory and main memory can be expressed in terms of the number of words or bytes, the capacity of external or secondary storage is measured in terms of bytes.
- **Storage cost**: Another key factor that is of prime concern in a memory system is cost. It is normally expressed per bit. It is obvious that lower costs are desirable. It is worth noting that as the access time for memories increases, the cost decreases.
- **Access time**: It is the time required to locate and retrieve the data from the storage unit. It is dependant on the physical characteristics and the access mode used for that device. Primary storage units have faster access time as compared to secondary storage units.
- **Access mode**: Memory is considered to consist of various memory locations. Access mode refers to the mode in which information is accessed

from the memory. Memory devices can be accessed in any of the following ways:

- ***Random Access Memory (RAM)***: It is the mode in which any memory location can be accessed in any order in the same amount of time. Ferrite and semiconductor memories, which generally constitute the primary storage or main memory, are of this nature.
- ***Sequential access***: Memories that can be accessed only in a predefined sequence are sequential access memories. Since sequencing through other locations precedes the arrival at a desired location, the access time varies according to the location. Information on a sequential device can be retrieved in the same sequence in which it was stored. Songs stored on a cassette, that can be accessed only one by one, is an example of sequential access. Typically, magnetic tapes are sequential access memory.
- ***Direct access***: In certain cases, the information is neither accessed randomly nor in sequence, but something in between. In this type of access, a separate read/write head exists for each track, and on a track the information can be accessed serially. This semi-random mode of access exists in magnetic disks.

- **Permanence of storage**: If the storage unit can retain the data even after the power is turned off or interrupted, it is termed as non-volatile storage. While, if the data is lost once the power is turned off or interrupted, it is called volatile storage. It is obvious from these properties that the primary storage units of the computer systems are volatile, while the secondary storage units are non-volatile. Non-volatile storage is definitely more desirable and feasible for storage of large volumes of data.

Memory Capacity

Capacity, in a computer system, is defined in terms of the number of bytes that it can store in its main memory. This is usually stated in terms of kilobytes (kB) which is 1024 bytes or megabytes (MB) which is equal to 1024 KB (10,48,576 bytes). The rapidly increasing memory capacity of computer systems has resulted in defining the capacity in terms of gigabytes (GB) which is 1024 MB (1,07,37,41,824 bytes).

Thus, a computer system which has a memory of 256 MB is capable of storing (256 × 1024 × 1024) 26,84,35,456 bytes or characters.

Main memory

Static and dynamic RAM

The main memory is the central storage unit in a computer system. It is a relatively large and fast memory and is used to store programs and data during computer operations. The principal technology used for the main memory is based on semiconductor integrated circuits. Integrated circuit RAM chips are available in two possible modes, static and dynamic.

Static RAM (SRAM) stores binary information using clocked sequential circuits. The stored information remains valid only as long as power is applied to the

unit. On the other hand, Dynamic RAM (DRAM) stores binary information in the form of electric charges that are applied to the capacitors inside the chip. The stored charge on the capacitors tends to discharge with time and so must be periodically recharged by refreshing the dynamic memory. Dynamic RAM offers larger storage capacity and reduced power consumption. Therefore, large memories use dynamic RAM, while static RAM is mainly used for specialized applications.

The different types of memory discussed here belong to the read/write type. What about a memory where only one of the operations is possible, e.g., if we allow only reading from the memory (cannot change the information in the memory)? The memory might have some major importance; an important bit of the computer's operating system which normally does not change, can be stored in this type of memory. Such a memory is called ROM Read Only Memory.

Read Only Memory (ROM)

Most of the memory in a general-purpose computer is made of RAM integrated circuit chips, but a portion of the memory may be constructed using ROM chips. Originally, RAM was used to refer to random-access memory, but now we use the term read/write memory to distinguish it from read-only memory (since ROM is also random access). RAM is used for storing bulk of the programs and data that are subject to change, while ROM is used to store programs that are permanently resident in the computer and do not change once the production of the computer is completed.

Among other things, the ROM portion of the main memory is used for storing an initial program called the bootstrap loader. The bootstrap loader is a program whose function is to start the operating computer software when power is turned on. Since RAM is volatile, its contents are destroyed when power is turned off. The contents of ROM remain unchanged even after the power is turned off and on repeatedly.

Read-only memories can be manufacturer-programmed or user-programmed. When the manufacturer burns the data into the circuitry of the computer, it is called manufacturer-programmed ROM. For example, a personal computer manufacturer may store the boot program permanently in the ROM chip of the computers manufactured by it. Note that such chips are supplied by the manufacturer and are not modifiable by the users. This is an inflexible process and requires mass production. Therefore, a new type of ROM called PROM (Programmable Read-only Memory) was designed. This is also non-volatile in nature and can be written only once using some special equipment. The writing process in PROM can be performed electrically by the supplier or the customer.

In both ROM and PROM, the write operation can be performed only once and whatever is written cannot be changed. But what about the cases where you mostly read but also write a few times? Another type of memory chip called EPROM (Erasable Programmable Read-only Memory) was developed to take care of such situations. EPROMs are typically used by R&D personnel who experiment by changing micro-programs on the computer system to test their efficiency.

Further, EPROM chips are of two types: EEPROMs (Electrically EPROM) in which high voltage electric pulses are used to erase stored information, and

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UVEPROM (Ultra Violet EPROM) in which stored information is erased by exposing the chip for some time to ultraviolet light.

Figure 2.4 shows the various types of random access memories.

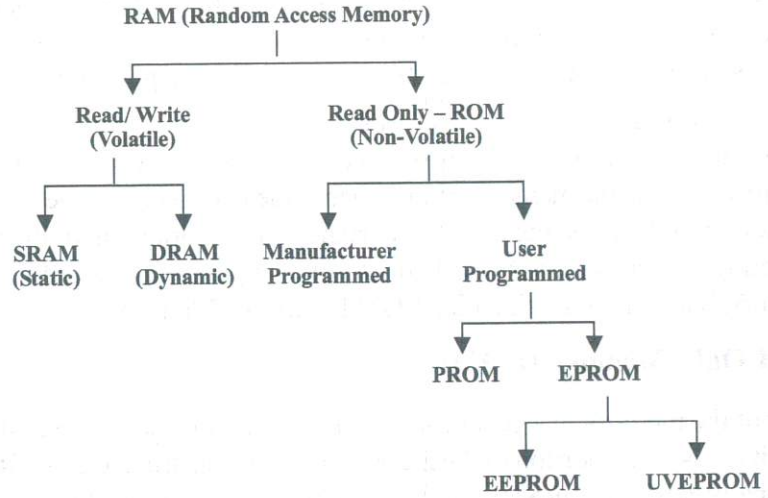

Fig. 2.4 Types of Random Access Memories

Cache Memory

Cache memories are small, fast memories placed between the CPU and the main memory. They are faster than the main memory with access times closer to the speed of the CPU. Although caches are fast, they are also very expensive and so are used only in small quantities. For example, a cache of size 64K is normally used in Pentium IV machines. Cache memories are therefore intended to provide fast speed memory retrieval without sacrificing the size of the memory.

If the memory is so small, how can it be advantageous in increasing the overall speed of memory? The answer to this lies in the phenomenon known as locality of reference.

2.5.3 I/O Devices

A computer will be of no use if it is not able to communicate with the external world. It must, therefore, have a system to receive information from the outside world (users and other computers) and must be able to communicate results to the external world. Computers have an input–output subsystem, referred to as I/O subsystem, which provides an efficient mode of communication between the central system and the outside world. Programs and data must be entered into the computer memory for processing, and results obtained from computations must be displayed or recorded for the user's benefit.

This can be explained through a very common scenario. Suppose the average marks of a student need to be calculated, based on the marks obtained in various subjects by the student. The marks would typically be available in the form of a document containing the student's name, roll number, and marks scored in each subject. This data must first be stored in the computer's memory after converting it into machine-readable form. The data will then be processed (average marks calculated) and sent from the memory to the output unit that will present the data in a form that can be read by users.

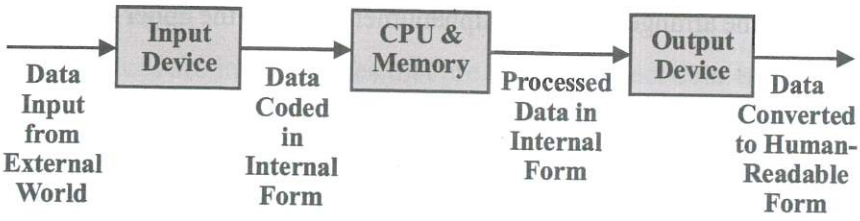

Fig. 2.5 Role of I/O Devices in a Computer System

The I/O devices that provide a means of communication between the computer and the outside world are known as peripheral devices. This is because they surround the CPU and the memory of a computer system. While input devices are used to enter data from the outside world into the primary storage, output devices are used to provide the processed results from primary storage to users. Figure 2.5 shows the role of input/output devices in a computer system.

In this unit, we will discuss the various input devices available for data input.

As mentioned earlier in this section, input devices are used to transfer user data and instructions to the computer. The most commonly used input devices can be classified into the categories of:

- Keyboard devices (general and special purpose, key-to-tape, key-to-disk, key-to-diskette)
- Point-and-draw devices (mouse, trackball, joystick, light pen, touch screen etc.)
- Scanning devices (optical mark recognition, magnetic ink character recognition, optical bar code reader, digitizer, electronic-card reader, etc.)
- Voice recognition devices
- Vision-input devices (webcam, video camera, etc.)

General Purpose Keyboard

The most familiar means of entering information or data into a computer is through a typewrite-like keyboard that allows a person to enter alphanumeric information directly.

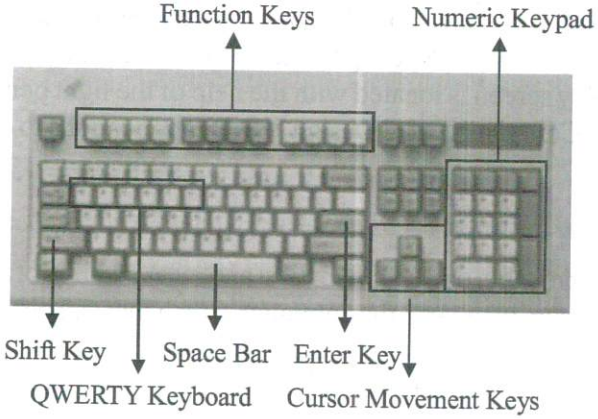

Fig. 2.6 QWERTY Keyboard Layout

The most popular keyboard used today is the 101-keys with a traditional QWERTY layout, having an alphanumeric keypad, 12 function keys, a variety of special function keys, numeric keypad, and dedicated cursor control keys. It is so

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called due to the arrangement of its alphanumeric keys in the upper left row (refer Figure 2.6).

Mouse

A mouse is a small device that a computer user pushes across a desk surface in order to point to a place on a display screen and to select one or more actions possible from that position. The mouse first became a widely used computer tool when Apple Computer made it a standard part of the Apple Macintosh. Today, the mouse is an integral part of GUI of any personal computer. The mouse apparently got its name by being about the same size and color as a toy mouse.

Trackball

A trackball is a pointing device that is much like an inverted mouse. It consists of a ball inset in a small external box or adjacent to—and in the same unit as the keyboard of some portable computers. It is more convenient and requires much less space than the mouse since here the whole device is not moved (as in the case of a mouse). Trackball comes in various shapes but supports the same functionality. Typical shapes used are a ball, a square and a button (typically seen in laptops).

Joystick

A joystick is a vertical stick that moves the graphic cursor in the direction the stick is moved. It consists of a spherical ball, which moves within a socket and has a stick mounted on it. The user moves the ball with the help of the stick that can be moved left or right, forward or backward, to move and position the cursor in the desired location. Joysticks typically have a button on top that is used to select the option pointed by the cursor. Video games, training simulators and control panels of robots are some common uses of the joystick.

Light Pen

A light pen is a pen-shaped device allowing natural movement on the screen. It is made up of a light sensitive cell and a lens assembly designed in such a way that it focuses onto itself any light in its field of view. The pen contains a light receptor and is activated by pressing the pen against the display screen. The receptor is the scanning beam that helps in locating the position of the pen (X and Y coordinates on screen). Suitable system software is provided to initiate the desired action once the area on the display screen is located with the help of the light pen. Light pens are typically used in Computer Aided Design (CAD) applications to directly draw on screen.

Touch Screen

A touch screen is probably one of the simplest and most intuitive of all input devices. It uses optical sensors in or near, the computer screen that can detect the touch of a finger on the screen. Once the user touches a particular screen position, sensors communicate the position to the computer. This is then interpreted by the computer to understand the user's choice for input.

The most common usage of touch screens is in information kiosks where users can receive information at the touch of a screen. These devices are becoming increasingly popular today.

Scanning Devices

Scanning devices are input devices that are used for direct data entry from the source document into the computer system. Scanners facilitate the capturing of information and storing it in a graphical format for displaying it back on the graphical screen. They consist of two components, one to illuminate the page so that the optical image can be captured and the other to convert the graphical image into a digital format for storing. The graphical images thus scanned can be seen and processed directly by the computer.

There are two types of scanners, CONTACT and LASER. Both bounce a beam of light off an image, and then measure the reflected light to determine the value of the image. Hand-held contact scanners make contact as they are brushed over the printed matter to be read. Laser-based scanners are more versatile and can read data passed near the scanning area (refer Figure 2.7(a) and (b)).

Fig. 2.7(a) *A Hand-held Scanner*

Fig. 2.7(b) *A Flat-bed Scanner*

Hand-held scanners are used where the information to be scanned or the volume of documents to be scanned is very low. They are much cheaper as compared to the flat-bed scanners.

Capturing information using scanners reduces the possibility of human error typically seen during large data entry. The reduction in human intervention improves the accuracy of data and provides for timeliness of the information processed.

Most recent trends for data input is towards source data automation. The equipment used for source data automation capture data as a by-product of a business activity thereby completely eliminating manual input of data. Some common examples of these are described below.

Optical Mark Recognition

Optical Mark Recognition (OMR) devices can sense marks on computer readable paper. This kind of device is typically used by academic institutions to grade aptitude tests where candidates need to mark the correct option from a number of alternatives, on a special sheet of paper. These answer sheets can then be directly read by the OMR device and can be used for further processing by the computer.

The actual technique used by an OMR device once again involves focusing light on the page being scanned thereby detecting the reflected light pattern for the marks. Pencil marks made by the user reflect light determining which responses are marked.

Magnetic Ink Character Recognition

Magnetic Ink Character Recognition (MICR) is similar to optical mark recognition and is used exclusively by the banking industry. MICR devices are used by the banking industry to read the account numbers on cheques directly and subsequently do the necessary processing.

Banks using the MICR technology print cheque books on special types of paper. The necessary details of the bank (like the bank's identification code, relevant account number and cheque number) are pre-printed on the cheques using an ink that contains iron oxide particles that can be magnetized. (refer Figure 2.8).

Fig. 2.8 *A Bank Cheque using MICR Technology*

MICR readers are used to read and sort cheques and deposits. An MICR reader-sorter reads the data on the cheques and sorts the cheques for distribution to other banks and customers or for further processing.

Optical Barcode Reader

Data coded in the form of small vertical lines forms the basis of barcoding. Alphanumeric data is represented using adjacent vertical lines called barcodes. These are of varying widths and spacing between them used to uniquely identify books, merchandise in stores, postal packages, etc.

Figures 2.9(a) and (b) give an example of a bar code used on one of the books for its unique identification.

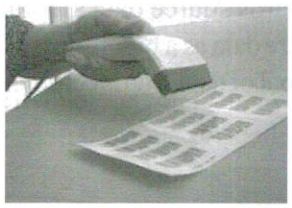

Fig. 2.9(a) *Barcode Example*

Fig. 2.9(b) *Barcode Reader*

An Optical Barcode Reader (OBR) uses laser beam technology. The laser beam is moved across the pattern of bars in a barcode. These bars reflect the beam in different ways. The reflected beam is then sensed by a light sensitive detector which then converts the light patterns into electrical pulses thereby transmitting them to logic circuits for further conversion to alphanumeric value. Barcode devices are available as hand-held devices.

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Digitizer

Digitizers are used to convert drawings or pictures and maps into a digital format for storage into the computer.

Fig. 2.10 Digitizing Tablet

A digitizer consists of a digitizing or graphics tablet, which is a pressure sensitive tablet, and a pen with the same X and Y coordinates as on screen. Some digitizing tablets also use a crosshair device instead of a pen. The movement of the pen or crosshair is reproduced simultaneously on the display screen. When the pen is moved on the tablet, the cursor on the computer's screen moves simultaneously to the corresponding position on screen (X and Y coordinates). This allows the user to draw sketches directly or input existing sketched drawings easily. Figure 2.10 shows a digitizing tablet.

Digitizers see most common usage by architects and engineers as a tool for Computer Aided Designing (CAD).

Computer Output Units

An output device is an electromechanical device that accepts data from the computer and translates them into a form that can be understood by the outside world. The processed data, stored in the memory of the computer, is sent to an output unit, which then transforms the internal representation of data into a form that can be read by the users.

The output can normally be produced in two ways — on a display unit/device or on paper. Other kinds of output like speech output and mechanical output are also used in certain applications. Output produced on display units or speech output that cannot be touched, is referred to as soft copy output while output produced on paper or material that can be touched, is known as hard copy output.

A wide range of output devices are available today and can be broadly classified under the categories of:

- Display devices
- Printers (dot matrix, inkjet, laser)
- Plotters (flatbed, drum)

Display Devices

One of the most common and important peripherals in a computer system is the display device. Conventional computers used display terminals known as alphanumeric terminals. These used a form of multi-dot (7×5 or 9×7) array to display characters. These were used to read text information displayed on screen. The increasing demand for displaying graphs and pictures, for visual presentation of information (more effective for user interaction), brought about the advent of graphic display devices.

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Graphic display is typically made up of a series of dots called 'pixels' (picture elements) whose pattern produces the image. Each dot on the screen can be addressed uniquely and directly. Owing to the fact that each dot can be addressed as a separate unit, it provides greater flexibility for drawing pictures.

Display screen technology may be one of the three categories:

Cathode Ray Tube (CRT): The main components of a cathode ray terminal are the electron gun, the electron beam controlled by an electromagnetic field and a display screen which is phosphor-coated. The screen's phosphor-coating is organized into a grid of dots called pixels.

The electron gun emits an electron beam, which is directed towards the phosphor-coated display by the electromagnetic field and this in turn creates the image.

There are two types of CRT displays:

- **Vector CRT display:** In which the electron beam is directed only to places where the image is to be created.
- **Raster scan display:** In which image is projected on screen by directing the electron beam across each row of the picture elements from top to the bottom of the screen. This type of display provides a high dynamic capability since the image is continuously refreshed. It offers full colour display at a relatively low cost and is, therefore, becoming increasingly popular.

The quality of display is indicated by the resolution of the display device. The number of horizontal and vertical pixels determines resolution. Typical resolutions in graphic display range from (800 × 600) to (640 × 768) to (1024 × 1024) pixels.

Based on the resolution and the number of colors supported, several standards for color monitors have evolved. The most popular of these include:

- Color Graphics Adapter (CGA), which has a resolution of (320 × 200) and supports up to 16 colors.
- Extended Graphics Adapter (EGA) has a resolution of (640 × 350) and supports up to 16 colors.
- Video Graphics Adapter (VGA) has a resolution of (640 × 480) and supports up to 256 colors.
- Super VGA having a resolutions ranging (800 × 600) to (1280 × 1024) and supporting up to 256 or more colors.

Note that each one of these is implemented by installing an add-on card in the computer, commonly known as graphics adapter or the video card. This card is then connected to the appropriate monitor.

Liquid Crystal Display (LCD): Introduced in watches and clocks in the 1970s and is now applied to the display terminals. In this, the cathode ray tube was replaced by liquid crystal to produce the image. It does not have colour capability and the image quality is relatively poor. The main advantage of LCD is its low energy consumption. It finds its most common usage in portable devices where compactness and low energy requirements are of prime importance.

Projection Display: Projection display technology is characterized by replacing the personal size screen with large screens upon which the images are

projected. These systems are connected to the computer and whatever appears on the computer terminal gets enlarged and projected on a large screen. These are being used today for large group presentations.

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Monitors

Monitors use a CRT to display information. It resembles a television screen and is similar to it in other respects. Figure 2.11 shows a CRT monitor.

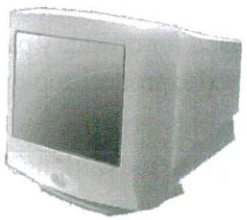

Fig. 2.11 CRT Monitor

The monitor is typically associated with a keyboard for manual input of characters. The screen displays information as it is keyed in, enabling a visual check of input before it is transferred to the computer. It is also used to display the output from the computer and hence serves as both an input and an output device.

The monitor along with the keyboard is called a Visual Display Unit (VDU).

This is the most commonly used input/output device today and is also known as a soft copy terminal. A printing device is usually required to provide a hard copy of the output.

Printers

Printers are used for producing output on paper. There are a large variety of commercially available printers today (estimated to be 1,500 different types). These printers can be classified into categories based on:

- Printing technology
- Printing speed
- Printing quality

Printing technology: Printers can be classified as impact or non-impact printers, based on the technology they use for producing output.

Impact printers use variations of standard typewriter printing mechanism where a hammer strikes the paper through an inked ribbon. These printers have a mechanism that touches the paper in order to create an image. Dot matrix printers and character printers fall under this category.

Non-impact printers do not touch the paper when creating an image. They use chemical, heat or electrical signals to etch symbols on paper. Many of these require special coated or treated paper. Inkjet, laser and thermal printers fall under this category of printers.

Printing speed: Refers to the number of characters printed in a unit of time. Based on speed these may be classified as character printer (prints one character at a time), line printers (print one line at a time), and page printers (print the entire page at a time). Printer speeds are, therefore, measured in terms of characters-per-

second or cps for a character printer, lines-per-minute or lpm for a line printer, and pages-per-minute or ppm for a page printer.

Printing quality: Is determined by the resolution of printing and is characterized by the number of dots that can be printed per linear inch, horizontally or vertically. It is measured in terms of dots-per-inch or dpi. Printers can be classified as near-letter-quality or NLQ, letter-quality or LQ, near-typeset-quality or NTQ, and typeset-quality or TQ based on their printing quality. NLQ printers of resolutions of about 300 dpi, LQ of about 600 dpi, NTQ of about 1200 dpi, and TQ of about 2000 dpi. NLQ and LQ printers are used for ordinary printing in day-to-day activities, while NTQ and TQ printers are used to produce top-quality printing, typically required in the publishing industry.

The section that follows explains the working of some commonly used printers.

Dot Matrix

Dot matrix printers were the most popular impact printers used in personal computing. These printers use a print head consisting of a series of small pins to strike a ribbon coated with ink, causing the ink to transfer to the paper at the point of impact. Characters thus produced are in a matrix format. The shape of each character, i.e., the dot pattern, is obtained from information held electronically. (refer Figures 2.12(a) and (b)).

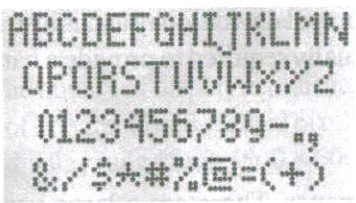

Fig. 2.12(a) Characters Formed using Dots

Fig. 2.12(b) An Dot Matrix Printer

The speed, versatility and ruggedness, combined with low cost, tend to make such printers particularly attractive in the personal computer market.

Typical printing speeds in case of dot matrix printers range between 40–1000 cps (characters per second). The one major disadvantage of this technology is that the print quality is low.

Inkjet

Inkjet printers use a series of nozzles to spray drops of ink directly on the paper. These, therefore, fall under the category of non-impact printers. Figure 2.13 shows an inkjet printer.

Fig. 2.13 An Inkjet Printer

The print head of an inkjet printer consists of a number of tiny nozzles that can be selectively heated up in a few microseconds by an IC register. When this happens, the ink near it vapourizes and is ejected through the nozzle to make a dot

on the paper placed in front of the print head. The character is printed by selectively heating the appropriate set of nozzles as the print head moves horizontally.

Laser

Laser printers use dry ink (toner), static electricity, and heat to place and bond the ink onto the paper. They use a combination of laser and photocopier technology. Printing is achieved by deflecting laser beam onto the photosensitive surface of a drum after which the latent image attracts the toner to the image. The toner is then electrostatistically transferred to the paper and fixed into a permanent image. Figure 2.14 shows a lazer printer.

***Fig. 2.14** A Laser Printer*

Laser printers are capable of converting computer output into print, page by page. Since characters are formed by very tiny ink particles, they can produce very high quality images (text and graphics), generally offer a wide variety of character fonts and are silent and fast in use (refer Figure 2.14).

Laser printers are faster in printing speed than other printers discussed above. Their speeds can range from 10 pages a minute to about 200 pages per minute, depending upon the make/model.

Laser is high quality, high speed, high volume and non-impact technology that works on plain paper or pre-printed stationary. This technology is relatively expensive but is becoming very popular because of the quality, speed and noiseless operations.

Plotters

Plotters are used to produce graphical output on paper. It is a device capable of producing charts, drawings, graphics, maps, etc. It is much like a printer but is designed to print graphs instead of alphanumeric characters.

Based on the technology used, plotters may be pen plotters or electrostatic plotters. While pen plotters have an ink pen attached to draw the images, electrostatic plotters work similar to a laser printer. Image is produced by charging the paper with a high voltage. This voltage attracts the toner, which is then melted on the paper with heat. Electrostatic plotters are fast but the quality is generally considered to be poor when compared to pen plotters. This is why pen plotters are more extensively used as compared to electrostatic plotters. Flatbed plotters and drum plotters constitute the most commonly used plotters.

2.5.4 Types of Computers (Mini, Micro, Mainframe and Personal Computers)

Computers are classified on the basis of their speed of operation, memory capacity, hardware facilities and price. In many cases, there is a considerable amount of

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overlap among groups. The classification of the digital computer based on the processing hardware is given below.

- Mainframe computers
- Minicomputers
- Microcomputers

Mainframe Computers

Mainframe computers support a number of users to access a variety of software applications. They are also called organizational computers because they are used in large organizations. The major characteristics of a mainframe computer are as follows:

- It offers extensive problem-solving capabilities.
- It works at a very high speed. A large mainframe computer can process more than 100MIPS (Million Instructions Per Second).
- It has a high, memory capacity, measured in gigabytes or more.
- It is very expensive.
- It can handle multiple applications within a timesharing environment. This provides many users with the ability to perform different tasks.
- It can serve as the heart of a teleprocessing system with remote connections all over the world.
- It can act as a database server and other computers can network with it.
- Governments, universities and large business organizations use mainframe computers. Such organizations have extensive processing needs.
- It is commonly used for complex problem solving or large-volume jobs. Banks, insurance companies and large research projects involving extensive processing demands and fast processing speeds use mainframe computers.

Minicomputers

Minicomputers are a scaled-down version of mainframe computers. The processing power and the cost of minicomputers are less than that of mainframe computers. Minicomputers have larger memory sizes and faster processing speeds than microcomputers. Minicomputers are also called workgroup systems because they are well suited to the needs of smaller workgroups within a large organization. The major characteristics of a minicomputer are as follows:

- They have extensive problem solving capabilities.
- They have moderate memory capacity measured in megabytes or gigabytes.
- They have high processing speeds and operating systems with multitasking and network capabilities.
- They can be equipped with drives for floppy disks, magnetic tapes, compact disks, and hard disks.
- They can serve as network servers.
- Large organizations use minicomputers instead of one mainframe.

Microcomputers

Microcomputers are developed from advanced computer technology. They are commonly used in homes, classrooms and in the workplaces. Microcomputers can be home computers, personal computers, laptops, personal digital assistants, etc. They are powerful and easy to operate. In recent years, computers have become portable and affordable. The major characteristics of microcomputers are as follows:

- They are capable of performing data processing tasks and can solve numerical programs. Microcomputers work faster like minicomputers.
- They have moderate memory capacity measured in megabytes.
- They are inexpensive. A variety of microcomputers is available to suit smaller business organizations and educational institutions.
- The processing speed of microcomputers is measured in megahertz. A microcomputer running at 90MHz works approximately at 90 MIPS.
- Microcomputers are equipped with drives for floppy disks, compact disks and hard disks.
- Only one user can operate a microcomputer at a time.
- They are normally dedicated to one job. Millions of people use microcomputers to increase their personal productivity.
- Useful accessory tools like clock, calendar, calculator, daily schedule reminders, scratch pads and so on, are available in microcomputers.
- Laptop computers, also called notebook computers, are microcomputers. They use a battery power source. Laptop computers use a keyboard, mouse, floppy disc drive, CD drive, hard disk drive and monitor. They are costlier than personal computers.

Personal Computers (PCs)

Personal computers (refer Figure 2.15) are microcomputers commonly used for commercial data processing, Desktop Publishing (DTP), engineering applications and so on.

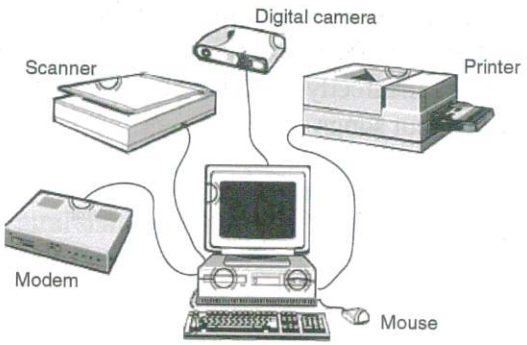

Fig. 2.15 A Computer and its Peripherals

Components of a Computer System

A personal computer, commonly available today, comprises a processor (Pentium IV), a keyboard, a mouse, a Floppy Disk Drive (FDD), a Hard Disk Drive (HDD), a Compact Disk Drive (CDD), a colour monitor, a printer (dot matrix/inkjet/laser),

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RAM (Random Access Memory) and ROM (Read Only Memory). The microprocessor/CPU, RAM, ROM and other supporting circuitry are interconnected on a single board called motherboard as shown in Figure 2.16.

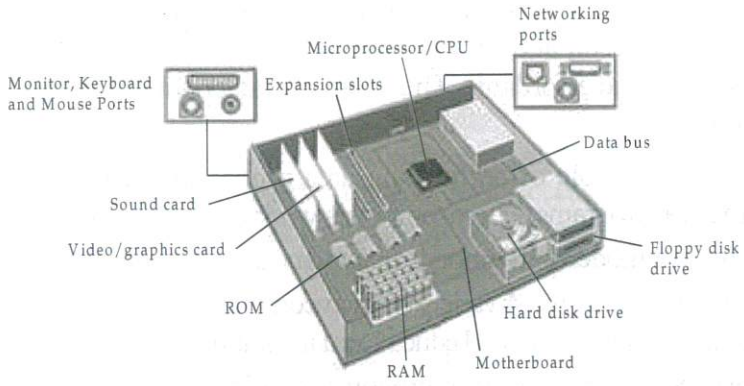

Fig. 2.16 Motherboard and CPU

2.5.5 Auxiliary Storage Devices

As already discussed, the RAM is a volatile memory having limited storage capacity. The cost of RAM is also relatively higher as compared to secondary memory. Logic dictated that a relatively cheaper media, showing some sort of permanence of storage, be used. As a result additional memory called ***external*** or ***auxiliary memory*** or ***secondary storage*** is used in most computers.

The magnetic medium was found to be long lasting and fairly inexpensive, and therefore became an ideal choice for large storage requirements. Magnetic tapes and disks are commonly used as storage media. With the advancements in optical technology, optical disks are making inroads as one of the major secondary storage devices.

Magnetic Disk

Magnetic disks are a direct access medium and hence the most popular online secondary storage devices. Direct access devices are also called random access devices because information is literally available at random or in any order. Access to any location on the device is direct and so approximately equal access time is required for each location. An example of this is a music CD where if you wish to listen to the 5th song, you can directly select the 5th track. It does not require you to fast forward the previous four songs.

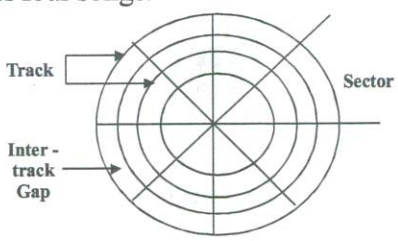

Fig. 2.17 Logical Layout of a Magnetic Disk

A magnetic disk is a circular plate made of metal or plastic, coated with magnetized material. Often both sides of the disk are used. Data is recorded on the disk in the form of magnetized and non-magnetized spots (not visible to the naked eye) representing 1s and 0s.

Data is stored in concentric rings or ***tracks***. To minimize the interference of magnetic fields, the adjacent tracks are separated by ***inter-track gaps***. Tracks are commonly divided into sections called sectors. In most systems, the minimum quantity of information that can be transferred is a sector. Usually 8 or more sectors per track are found. Figure 2.17 shows a layout of a magnetic disk.

A track in a given sector near the circumference is longer than the track near the centre of the disk. If bits are recorded with equal density, some tracks would contain more bits than the other tracks. To ensure that each sector can store equal amounts of data, some disks use variable recording density with higher density on tracks near the centre than on tracks near the circumference.

Hard Disk

Unlike floppy disks, hard disks are made up of rigid metal. The sizes for the disk platters range between 1 to 14 inches in diameter. Depending on the way they are packaged, hard disks can be categorised as disk packs or Winchester disks.

- **Disk packs:** It consist of two or more hard disks mounted on a single central shaft, because of this, all disks in a disk pack rotate at the same speed. It consists of separate read/write heads for each surface (excluding the upper surface of the top most disk platter and the lower surface of the bottom most disk platter, as mentioned earlier in this unit). Disk packs are removable in the sense that they can be removed and kept offline when not in use (typically stored away in plastic cases). They have to be mounted on the disk drive before they can be used. Thus, different disk packs can be mounted on the same disk drive at different instances, thereby providing virtually unlimited (modular) storage capacity. Figure 2.18 shows a disk pack.

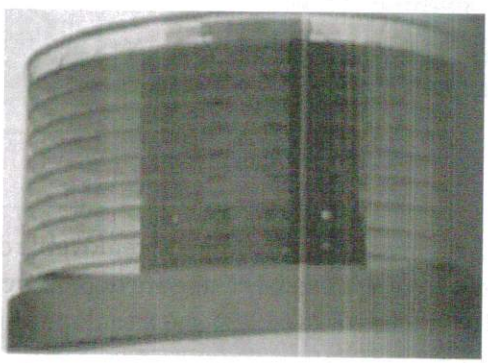

Fig. 2.18 *A Disk Pack*

- **Winchester disks:** It also consist of two or more hard disk platters mounted on a single central shaft but are of the fixed type. The disk platters are sealed in a contamination-free container. Due to this fact all the disk platters, including the upper surface of the top most disk platter and the lower surface of the bottom most platter, are used for storing data. So, even though Winchester disks have limited storage capacity as opposed to disk packs, they can store larger amounts of data as compared to the same number of disk platters. Figure 2.19 shows a Winchester disk.

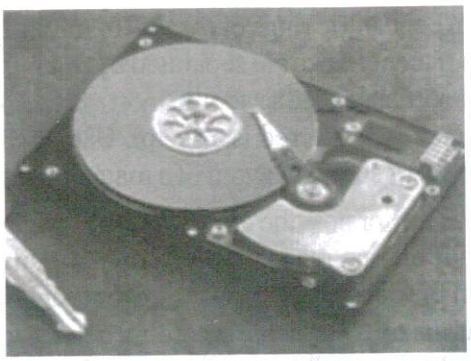

Fig. 2.19 A Winchester Disk

Another kind of disk called the zip disk is very common today. This consists of a single hard disk platter encased in a plastic cartridge. Such a disk typically has a capacity of about 100 MB. The zip drive can further be fixed or portable. The fixed zip drive is permanently connected to the computer system while the portable ones can be carried around and connected to any computer system for the duration of its use. In both cases however, the zip cartridge (the actual storage medium) is portable just like a floppy, albeit with a nearly 100 times larger storage capacity. Figure 2.20 shows a zip disk and zip drive.

Fig. 2.20 Zip Disks and Zip Drive

Floppy Disk

The disks used with a floppy disk drive are small removable disks made of plastic coated with magnetic recording material. There are two sizes commonly used, with diameters of 5¼ and 3½ inches. Figure 2.21 shows a floppy disk.

- The 5¼ inch disk is a 5¼ inch diameter floppy disk. Earlier, such disks recorded data only on one side and were called single-sided (SS) disks. Today both the surfaces are used for recording and are called Double Sided (DS) disks. These are available in two capacities – Double Density (DD), and High Density (HD), where density refers to the number of bits that can be stored per square inch area.
- The 3½ inch disk is a disk of 3½ inch diameter. These record data on both sides and are therefore double sided disks. These disks come in three differentapacities – double density, high density, and very high density. These are smaller and can store more data than can the 5¼ inch disks.

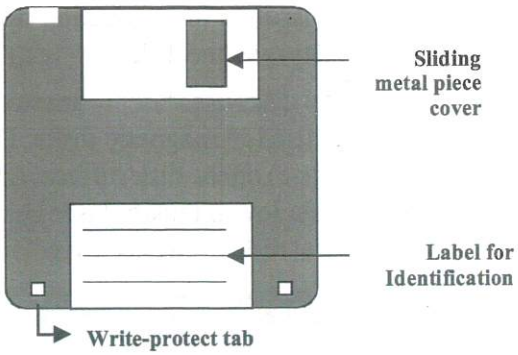

Fig. 2.21 A 3½ Inch Floppy Disk

The storage capacity for any disk can be calculated as:

Storage capacity = Number of recording surfaces × Number of tracks per surface × Number of sectors per track × Number of bytes per sector

Thus, for a 3-1/2 inch high density disk which has 80 tracks, 18 sectors/ track, and 512 bytes/sector, the disk storage capacity can be calculated as follows:

$2 \times 80 \times 18 \times 512 =$ 14,74,560 bytes or 1.4 MB (approximately)

Table 2.6 provides the necessary details and associated storage capacities of various kinds of floppy disks.

Floppy disks are extensively used in personal computers as a medium for distributing software to computer users.

***Table 2.6** Associated Storage Capabilities of Floppy Disks*

Size (Diameter in inches)	No. of Recording Surfaces	No. of Tracks	No. of Sectors/ Tracks	No. of Bytes/ Sector	Storage Capacity (Approx.)
5 ¼	2	40	9	512	3,68,640 bytes or 360kB
5 ¼	2	80	15	512	12,28,800 bytes or 1.2 MB
3 ½	2	40	18	512	7,37,280 bytes or 720 kB
3 ½	2	80	18	512	14,74,560 bytes or 1.4 MB
3 ½	2	80	36	512	29,49,120 or 2.8 MB

Optical Disk

Optical disks are storage devices with huge storage capacity. It is a relatively new storage medium and uses laser beam technology for writing and reading of data.

Optical disks consist of one large track that starts from the outer edge and spirals inward towards the centre (this is unlike the magnetic disk in which tracks are concentric circles on the disk platter). An optical disk is also split up into sectors

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Check Your Progress

24. Who invented the first mechanical adding machine?
25. Name three types of computers.
26. What is the rate of accuracy of analog computers?
27. How are single and two-digits used in binary counting?
28. What is the radix of decimal number system?
29. Define binary coded decimal.
30. How are 128 characters represented by ASCII?
31. Why is memory required in a computer?
32. What happens in the direct access mode?
33. What are peripheral devices?
34. What is the most common medium of entering information or data in a computer?
35. What forms the basis of bar coding?
36. Name three types of digital computer based on processing hardware.
37. Name the various types of microcomputers.
38. Why was the magnetic medium considered to be an ideal choice for large storage requirements?
39. Why are magnetic disks popular online secondary storage devices?

2.6 ANSWERS TO 'CHECK YOUR PROGRESS'

1. You can minimize the ribbon in the following ways:
   - By clicking on minimize ribbon button.
   - By double clicking the tab on the ribbon.
   - By right clicking the tab from the contextual menu and selecting minimize ribbon button.
   - By pressing Ctrl+F1 button.
2. .docm file format is used when the document is to be saved in macro-enabled documents.
3. When you click on the Ignore option then MS Word will skip checking the word or phrase in the document without making any change or modification to it.
4. To correct the Spelling Errors, follow the steps given below.
   - Place the insertion point at the word marked as error by MS Word. Now right-click the marked underlined word. The menu with spelling suggestions will appear.

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- Select the spelling that is correct for your document from the list of suggested spellings as shown below in the Illustration.
- MS Word will change the marked word with the corrected spelling in the document.

5. Header and footer are the important parts of any document. They are used for representing information about the document such as the page number, heading of the document etc. Header is present on the top of the document and footer is present at the bottom of the document.
6. File management is the task of maintaining the newly created folders or the existing folders in the computer. It involves various tasks such as saving the folder, maintaining the data and many more.
7. You can save the important files in the Libraries so that you can access the specific folder and files easily. The Libraries option appears on the left hand side of the screen.
8. Steps to change the font size are as follows:
   - Select a cell in which you want to set specific font size.
   - Click on Font Size from the Font on Home tab. There are two options for increasing and decreasing fonts.
   - Select font size from drop down list. Otherwise, click on increasing font or decreasing font.
9. Steps to change text alignment are as follows:
   - Select the cell.
   - Click on the Home tab.
   - Click on vertical Alignment and horizontal Alignment commands in Alignment group.
10. Arithmetic operators involve four major operations. These are: addition, subtraction, division and multiplication. These are known as the basic operators.
11. Replace function is used to remove the sequence of unwanted characters from the Excel sheet with another set of characters. These unwanted characters appear in the cell whenever the data is copied from one Excel sheet to another.
12. Steps to set the Font colour are as follows:
    - Select the cell.
    - Click on Home tab.
    - Click on Font colour option in Font group.
    - Select colour that you want to set in selected cell. Text in cell gets displayed with selected colour.
13. Steps to set border are as follows:
    - Select the cell.
    - Go to Home tab.

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- Click on Borders option in Font group.
- Select Border style that you want to use.

14. Conditional formatting is a tool of formatting a cell of the worksheet that contains some condition. In the conditional formatting there are different types of rules, bars of option, colour scale, etc.
15. Validation is the process of checking the values for desired type, that is, it provides the facilities to enter only those values as input in the cell which are appropriate. It is very useful in official documents or as database for the program.
16. Ribbon view is a substitute that provides the facilities of accessing the commands for applications. It is organized using a horizontal bar. It provides an easy way to access the commands, as all the commands are organized using tabs and groups.
17. This view is primarily used to sort slides and rearrange them. This view is also ideal to add or remove sections as it presents the slides in a more compact manner making it easier to rearrange them.
18. In PowerPoint 2010, by default, files are saved in .pptx format. In the previous version, files are saved in .ppt format.
19. You can change the order by simply right click the thumbnail of the slide that you want to move, and then drag it to the new location.
20. There are various options available in the Handouts group. You can choose any one of them like 1 Slide, 2 Slides. Also, you can print slides in horizontal and vertical manner by using 4 Slides Horizontal, 4 Slides Vertical, etc.
21. To group pictures: under Picture Tools, on the Format tab, in the Arrange group, Click, and then click Group.
22. Microsoft Office PowerPoint 2010 allows its users to use Shapes as Text Boxes, which implies that you can add a Shape to your slide and then you can use it as a Text Box to write text inside it, making presentations more beautiful and informative.
23. Shapes can be added to Microsoft Office PowerPoint 2010, using the Shapes option under the Illustrations group of the Insert Tab. You can insert any shape of your choice and use it to write text.
24. The first mechanical adding machine was invented by Blaise Pascal in 1642.
25. The three types of computers are digital computers, analog computers and hybrid computers.
26. The accuracy of result obtained from an analog computer is about 99 per cent.
27. In binary counting, single digits are used for none and one. Two-digit numbers are used for 10two and 11two [2 and 3 in decimal numerals].
28. The decimal number system has a base or radix of 10.
29. Binary Coded Decimal BCD is one of the early memory codes. It is based on the concept of converting each digit of a decimal number into its binary

equivalent rather than converting the entire decimal value into a pure binary form.

30. ASCII code uses 7 digits to represent 128 characters.
31. Memory in the computer system is required for storage and subsequent retrieval of instructions and data.
32. In direct type of access, a separate read/write head exists for each track and on a track the information can be accessed serially.
33. The I/O devices that provide a means of communication between the computer and the outside world are known as peripheral devices.
34. The most familiar means of entering information or data into a computer is through a typewriter-like keyboard that allows a person to enter alphanumeric information directly.
35. Data coded in the form of small vertical lines forms the basis of barcoding.
36. The three types of the digital computers based on processing hardware are mainframe computers, minicomputers and micro-computers.
37. Microcomputers can be home computers, personal computers, laptops, personal digital assistants, etc.
38. The magnetic medium was found to be long lasting and fairly inexpensive and therefore became an ideal choice for large storage requirements.
39. Magnetic disks are a direct-access medium and hence the most popular online secondary storage devices.

2.7 SUMMARY

- Info section gives important information related to file, by specifying its properties. It enables you to protect documents, check for issues and manage versions.
- In MS Word 2010, files are saved in the default format, which is .docx. This is because .docx format is more secured and damages can be easily recovered.
- There are two methods for saving a document in PDF or XPS format, both are given below:
  - o One method of saving the file in Pdf or Xps format is with the help of Save As button.
  - o Another method of saving the file in Pdf or Xps format is with the help of Save & Send section.
- The 'Print Preview' feature of MS Word helps you to view on the screen how the printed version of the document would look like before printing a hard copy. In latest versions of the MS Word (MS Word 2010 Onwards), there is 'NO' Print Preview Tab or Option.
- As an alternative, click on the File Tab then on the option Print from the menu that appears on the left side. The Print pane will be displayed. In the

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Print pane, click on the 'Page Setup' option to open Page setup dialog box. In the Page setup dialog box define the Margins, Paper Size and Layout options for setting the document text so that the text remains within the printable area.

- MS Word provides significant feature 'Proofing' for checking the text in the document by using the option 'Spelling & Grammar'. If you have made mistakes in the document while typing the text then you can use the numerous proofing features provides by MS Word to produce error-free and professional documents.
- Table consists of the rows and columns. Rows are horizontal and columns are vertical. At the intersection of the rows and column there is a cell which contains the text. We can format the tables according to our requirements.
- In Microsoft Excel 2010, various new features have been included which help in creating an effective and attractive worksheet.
- Microsoft Excel is used for storing the data in the form of table. It is used by several organizations to perform complex calculations, statistical analysis and tracking income and expenses.
- Excel sheet contains data in cells. These cells can be converted into table using Format as Table command. There are many built-in table styles available in Excel 2010. When you apply table style on cells Design tab appears.
- Hyperlink provides a connection enabling the user to open another worksheet or workbook or any website. Text written in any cell may be defined as hyperlink.
- Conditional formatting is a tool of formatting a cell of the worksheet that contains some condition.
- Excel file is a workbook that contains one or more worksheets. Formatting Excel sheet improves the presentation of the worksheet and makes it easy to use. By default, each Excel file has three worksheets.
- Ribbon view is a substitute that provides the facilities of accessing the commands for applications. It is organized using a horizontal bar. It provides an easy way to access the commands, as all the commands are organized using tabs and groups.
- Normal view is the default view in PowerPoint and this is primarily used to create and edit slides. User can create/ delete/ edit/ rearrange slides, add/ remove/ modify content and manipulate sections from this view.
- Reading view is new to PowerPoint 2010 and it was created mainly to review the slide show without losing access to rest of the Windows applications.
- In PowerPoint 2010, by default, files are saved in .pptx format. In the previous version, files are saved in .ppt format.
- Animation is one of the most common features of MS PowerPoint. It is used to make an attractive presentation and for creating the interest in

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audience. MS PowerPoint 2010 provides different varieties of animations that can be applied to text, picture or other graphics in multiple ways.

- Timing group of Animations tab allows user to adjust the sequence and timing of selected animations. User can also adjust settings if an animation should be performed when the mouse is clicked or automatically.
- Microsoft Office PowerPoint 2010 allows its users to easily use audio-visual content in the presentation. It supports a large variety of video files such as, Windows Media File, MP4 Video, MPEG-2 TS Video and Window Media Video File, along with audio files such as ADTS Audio, AIFF audio file (aiff), AU audio file, MP3 and MP4 audio files.
- A SmartArt can be easily inserted in MS PowerPoint 2010. SmartArt icon can be found in Illustrations group. The various graphics available in this option are All (basic block list, alternating hexagon, etc.), matrix, relationship, hierarchy, etc.
- SmartArt is a method, which helps to improve the artistic view of a presentation. SmartArt is nothing other than the visual representation of textual data presented in a document. You can create SmartArt graphics in PowerPoint, Excel, Outlook, and Word.
- You can modify the common print settings by using the drop-down menus. The print previews are automatically adjusted to allow you to see how the pages will appear before actually printing them.
- Charles Babbage, a nineteenth-century professor at Cambridge University, is considered the father of the modern digital computer. During this period, mathematical and statistical tables were prepared by a group of clerks.
- Analog computers are generally used in industrial process controls and to measure physical quantities such as pressure, temperature and so on. These do not use binary digits for computation.
- Hybrid computers are the combination of digital and analog computers. They use the best features of digital and analog computers.
- The hexadecimal number is formed from a binary number by grouping bits in groups of 4 bits each, starting at the binary point. This is a logical way of grouping, since computer words come in 8 bits, 16 bits, 32 bits and so on.
- A computer code that is very widely used for data interchange is called the 'American Standard Code for Information Interchange' or ASCII. Several computer manufacturers have adopted it as their computers' internal code.
- The total memory capacity of the computer can be visualized as being a hierarchy of components. It consists of all storage devices employed in a computer system from the slow but high-capacity auxiliary memory to a relatively faster main memory, to an even smaller and faster cache memory accessible to high-speed processing logic.
- Computers have an input–output subsystem, referred to as I/O subsystem, which provides an efficient mode of communication between the central system and the outside world.

- Scanning devices are input devices that are used for direct data entry from the source document into the computer system. Scanners facilitate the capturing of information and storing it in a graphical format for displaying it back on the graphical screen.
- Inkjet printers use a series of nozzles to spray drops of ink directly on the paper. These, therefore, fall under the category of non-impact printers. The print head of an inkjet printer consists of a number of tiny nozzles that can be selectively heated up in a few microseconds by an IC register.
- Microcomputers can be home computers, personal computers, laptops, personal digital assistants, etc. They are powerful and easy to operate.
- Logic dictated that a relatively cheaper media, showing some sort of permanence of storage, be used. As a result additional memory called external or auxiliary memory or secondary storage is used in most computers.
- Optical disks are storage devices with huge storage capacity. It is a relatively new storage medium and uses laser beam technology for writing and reading of data.
- Three optical memory devices that are becoming increasingly popular in various computer applications are CD-ROM, WORM and Erasable Optical disks.

2.8 KEY TERMS

- **Ribbon:** It is a set of tabs and commands to perform various sets of functions and operations on documents.
- **Border:** Border is used to add the border around the document that is on left, right, top and bottom side.
- **Header:** Header is added on the top of the document which contains the important information of the document such as title, page number and other information.
- **Footer:** Footer is added at the bottom of the document which contains the page number and other added information about the document.
- **Break:** Break is used to start the new line from the new page in the document.
- **Validation:** This is the process of verifying the data to determine if the data is of correct format and in the desired range.
- **Formatting:** It means changing the property or the style of cell according to the need of the user.
- **Review tab:** It contains Proofing, Language, Comments, and Compare options. It is utilized for spelling and grammar editing.
- **View tab:** The View tab manages how your screen looks as you create your presentation.
- **Table:** It is a representation in the form of rows and columns for managing and presenting the data.

- **Illustrations:** An illustration is the area which is used to insert different types of shapes, Charts, SmartArt graphics.
- **Digital computers:** These are commonly used for data processing and solving problems using programs.
- **Hexadecimal number:** It is formed from a binary number by grouping bits in groups of 4 bits each, starting at the binary point.

2.9 SELF-ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the names of the notes that are added at the end of the page and at the end of the document?
2. Write the steps involved in the creation of the table.
3. Write the steps involved in adding the break in the document.
4. Write the steps to add column to the table.
5. What is use of Sort command?
6. Which command does Excel use for replacing data?
7. Which sign will appear in header of each column when click on filter command?
8. What is use of Find command?
9. Name the basic arithmetic operators?
10. Why is the text function used?
11. How can one exit the slide show and return to the presentation?
12. What is the shortcut key to save the presentation?
13. What is the function of Design tab?
14. _____used to display information such as page numbers, the date and other information.

    (a) Cut and paste (b) Header and Footer (c) Find and Replace (d) None of these
15. Blank Presentation does not contain _____

    (a) Picture (b) Text (c) Content suggestion (d) All of these
16. Microsoft PowerPoint is a part of _____.

    (a) MS Word (b) MS Office (c) MS Excel (d) MS Access
17. Who is considered as the father of modern digital computer?
18. Name the various types of computers.
19. Give one difference between binary and octal number system.
20. Define ASCII.
21. Give any three criteria's of storage evaluation.

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22. What is a QWERTY keyboard?
23. What technology is used by the optical barcode reader?
24. What are the two types of CRT displays?
25. What is the use of a plotter?
26. How are digital computers classified?
27. Name any four characteristics of a microcomputer.
28. Define auxiliary memory.

Long-Answer Questions

1. Define table. Explain the different actions that can be performed with table.
2. Define header and footer. Write the steps involved in adding header and footer to the document and also explain how to remove the header and footer from the document.
3. Define border and shading. Explain the steps to add the border and shade to the word document and the possible actions that can be performed.
4. What do you understand by the term formatting? How is it done in MS Word 2010?
5. Why bullets and numbering is an important feature in MS Word?
6. What are the various steps for creating custom bullet and numbering?
7. Discuss the differences between MS Word 2010 and 2016.
8. How will you align a statement in vertically middle and horizontally center? Explain with example.
9. Prepare an Excel sheet to calculate the average of given numbers using the average function?

   The numbers are: 12, 43, 65, 32, 76, 72.
10. Prepare an Excel sheet to calculate the financial total using the PMT function?

    The data is:

    D2 - Rate

    D3 - no of payments

    D4 - Principal

    D5 - Payment

    E2 - 8%

    E3 - 34

    E4 - 5,000.00
11. Prepare an Excel sheet for Adidas showroom which contains the types of products, their prices and code of every product. After this, use the IF functions if number in B1 is less than 1500 print 100 else print 200, where column B is for prices of products.

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12. Make a small Excel file and with list of 20 student name and their height. Then, use conditional formatting to make the cell red for all those whose height is less than 170 cm. Also attach picture or snapshots.
13. What do you mean by the term Charts in Excel. Explain the different functions that are associated with Charts?
14. What are the differences between MS Excel 2010 and 2016?
15. Discuss the steps to insert the chart and entering the data into it.
16. How are tables useful in PowerPoint 2010 for organizing and presenting data?
17. Discuss Microsoft PowerPoint as the most popular program for creating the interactive presentations.
18. How can you insert charts in Microsoft PowerPoint 2010? Write the steps for inserting data in charts.
19. Elaborate the process of adding the animations and effects in your presentation?
20. Explain the new features added to PowerPoint 2016.
21. Give a brief description of the various generations of computers.
22. Differentiate between digital computers and hybrid computers.
23. Differentiate between binary and decimal number system.
24. Explain the use of BCD.
25. What does a memory system consists of? Explain.
26. Describe the role of I/O devices in a computer system.
27. Write a short note on display devices.
28. What is the difference between an inkjet printer and a laser printer? Elaborate.
29. Explain the characteristics of minicomputers?
30. Describe the process of storing data in magnetic disks.
31. Write short note on:
    (a) Hard disks
    (b) Optical disks
32. Explain the advantages and disadvantages of CD-ROM.

2.10 FURTHER READING

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UNIT 3 PROMINENT INFORMATION SYSTEMS, COMMUNICATION CONCEPTS AND NETWORKING

Structure

3.0 Introduction
3.1 Objectives
3.2 Office Automation Systems
3.3 Transaction Processing Systems
3.4 Decision Support Systems
3.5 Executive Support Systems
3.6 Expert Systems
3.7 Enterprise Resource Planning Systems
3.8 Communication Concepts
  3.8.1 Signal and Data
  3.8.2 Channel
  3.8.3 Baud Rate
  3.8.4 Bandwidth
  3.8.5 Bit Rate
  3.8.6 Simplex and Duplex Communication
3.9 Protocols and Standards
3.10 Transmission Impairments
3.11 Networks
3.12 Types of Networks
3.13 Communication Networks
3.14 Answers to 'Check Your Progress'
3.15 Summary
3.16 Key Terms
3.17 Self-Assessment Questions and Exercises
3.18 Further Reading

3.0 INTRODUCTION

Office automation refers to the varied computer machinery and software used to digitally create, collect, store, manipulate, and relay office information needed for accomplishing basic tasks. Raw data storage, electronic transfer, and the management of electronic business information comprise the basic activities of an office automation system. DSS is different from MIS in terms of its processing capabilities. This is because the information in DSS is processed to support the decision-making process for a manager, whereas in MIS, data is processed and

converted into information. Several forces are always at play within an organization. Executive Support Systems (ESS) which is designed for senior executives of organizations. Executives are responsible for the growth and survival of the organization. Expert systems offer an economical and practical way to capture, refine and proliferate management skills. These systems provide a framework in which to document the questions and answers that experts use to solve analytical and operational problems.

Computer networks, which are essential for the structure of an organization. Local Area Networks (LANs) offer reliable high-speed communication channels which facilitate communication processes. Therefore, this distributed processing system interconnects the information processing tools in a small area, such as a building complex, college grounds or a workplace structure. LANs allow multiple workstations to share access to multiple host computers, other workstations, printers and peripherals as well as connections to other networks. A computer network is an interconnection of various computer systems located at the same or different places. Networks help data transmission over distances. Speed, reliability, cost and accessibility are taken into account when considering a network. Data communication networks, components of a network, circuits, topologies and design goals, switched and non-switched.

In this unit, you will study about the office automation systems, decision support system, transaction processing systems, executive support systems, expert systems, enterprise resource planning systems, concepts of communication, networking, different types of computer network types, communication networks and topologies.

3.1 OBJECTIVES

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

- Describe the office automation systems
- Understand the decision support system
- Define the term transaction processing systems
- Learn about the executive support systems
- Understand expert systems
- Define the enterprise resource planning systems
- Explain the concepts of communication
- Now about the networking
- Understand the different types of computer network types
- Describe communication networks and topologies

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3.2 OFFICE AUTOMATION SYSTEMS

Office automation systems is a type of information system that aids in automating office tasks. It has a limited role in decision-making and is more useful for operational-level people. The information derived from this type of a system can be used for rule-based decision-making by managers at the operational level. This system, however, plays an important role in automating several functions of an office and thus helps in creating paperless offices. This system helps in increasing the productivity and efficiency of the office workforce by automating simple tasks. This system mostly deals with operational data. More and more modern businesses, today opt for a paperless office environment as this brings in unique advantages for the business, which are as follows:

- Office work becomes faster and process-driven.
- All basic level data is digitized and stored for future action.

An example of Office Automation System is the MS Office suite of software, which helps in automating simple office tasks like presentations and documentation.

Office Automation Systems (OAS) specify the application of computers and communication technology for executing office functions. These automation systems are the combination of *hardware*, *software* and *personnel* in information systems that process office transactions and support office activities at various levels. OAS also includes a wide range of support facilities, such as word processing and electronic mail. These facilities enhance the productivity of managers by providing them secretarial assistance and better communication facilities. Office activities may be grouped under two classes, which are:

1. Activities performed by clerical personnel like clerks, secretaries and typists. These personnel execute a number of operations like typing, scheduling of meetings, retrieving documents, calendar keeping and conferences.
2. Activities performed by executives like managers, engineers and other professionals, such as economists and researchers. They carry out a number of operations like conferencing, controlling performance, and production of information such as messages and reports.

Nowadays, computer-based office automation devices, such as fax machines and computer systems are used in offices. These computer-based Office Automation Systems not only fulfil the communication needs of office managers, but also help them to communicate with external entities such as investors and vendors. Some of the applications of the OAS are:

- **Word Processing:** This refers to the computer-assisted preparation of documents, such as letters and reports, using textual data. Text is entered through a keyboard that is displayed on the screen of a visual display unit. Data once entered into the screen through the keyboard can be manipulated in various ways. Data can be edited and stored on magnetic media such as a hard disk or a floppy disk. After this, the stored data can be reproduced

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using simple commands that eliminate the need for drafting the entire document again. In the word-processing system, spelling errors are automatically checked and pre-defined letters are generated. Currently, these word-processing systems can even be modified to understand and convert the dictation of the manager to text by using the word processor.

- **Electronic Filing:** This facilitates the storing of incoming and outgoing mails or documents on a magnetic medium. In this, the information is captured from documents and stored in the hard disk or on the magnetic medium for future reference. Computer-based electronic filing systems have the advantage of saving space and providing cross-reference indexes that can be easily modified. These cross-reference indexes contain pointers to the location of the document.
- **Electronic Mail:** Involves the transfer of letters and other documents through telecommunication lines, rather than physically delivering the documents. An electronic mail system requires a telecommunication network and software. This system speeds up the mail deliveries and reduces the cost and time taken by sending mail through paper. In addition, Local Area Networks (LANs) facilitate the sharing of data files and software among many different computer terminals. Workstations/terminals can also transfer data/messages to each other. Voice mail, which is another form of e-mail, transmits the messages in the form of digitized voice. The receiver can hear the spoken messages in the voice of the sender by dialing a voice-mail service.

String and Filing Data

String represents the collection of characters. Handling of character strings is the initialization, processing and manipulation of character or string. The character strings are handled and manipulated in implementing the system for following meaningful operations:

- Reading and displaying the string.
- Concatenating the string.
- Copying string from one location to another.
- Comparing the string as to whether they match or not.
- Extracting the part of string or character.

The filing system is designed to provide a simple filing system used for office automation system and applications. Its design goals and functionality are covered in the document. The strings are used with filing system and sent to the storage device for further processing with reference to decision support system and system implementation but for this the flash chip is required. The following constraints are checked to implement this chip for DSS:

- The flash is divided into sectors (128K).
- Each sector is divided into pages and each page is 264 bytes long.
- Pages can only be written as a whole.

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- Pages should be erased before being written.
- Each page can be written a limited number of times.
- Erases are on a larger granularity than writes, for example 64k-erases, 528-byte writes, etc.

Filing System is a customer service and developed to provide a mechanism for individuals to submit and track the processing of certain applications. The data (strings) is submitted to assist in getting the information provided by users. The filing system provides a question and answer format for users to follow to complete the form data and it also provides a user-friendly interface that helps for exact entry of form data. As the user progresses through the application process, the filing system automatically saves the user's data as the user navigates from system to system. Once the filing data has collected the submitted data from the user, the system transmits the data to the appropriate benefits for admin side. In these days, data warehousing processes separate Online Analytical Processing (OLAP) from Online Transactional Processing (OLTP) by creating a new information repository that integrates basic data from various sources, properly arranges data formats, and then makes data available for analysis and evaluation aimed at planning and decision-making processes. Filing data is used for storing, analysing and reporting taxpayer accounts and collections information.

Figure 3.1 shows that data can be retrieved and sent for modeling to analyse the data. This data can be string.

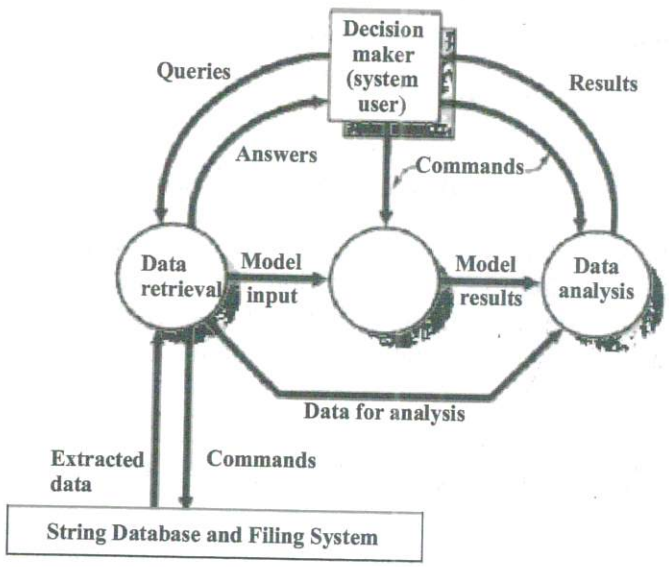

Fig. 3.1 String database and Filing System Approved by Decision-Maker

DSS uses one or more strings (data) to store the databases and sets of files that provide information to support the decision-maker. The strings are updated in filing system by suitable transaction processing system. It also supports the decision-maker as an external entity or even as a part of system.

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3.3 TRANSACTION PROCESSING SYSTEMS

Transaction processing systems are crucial for the smooth functioning of an organization. The objective of this system is to capture all transaction-related data between the organization and its external and internal customers. Typically, the transaction-level data is stored in a preformatted manner in a relational database for further action in the future. TPS is the most widely used form of information system, as it provides management with the flexibility of storing data in a structured manner and retrieving it at a later date using the query facility. The system also helps in aggregating and summarizing the data for creating management reports. These reports are further improved using visualization tools, which help management in understanding situations and scenarios better. The system deals with tactical data from within the organization.

An example of TPS is a sales management system with a relational database management system at the server-side back end and a customized front end to interact with the users.

The Transaction Processing System (TPS) is defined as an information system that processes transactions and produces reports that represent the automation of the fundamental, routine processing. These reports support business operations, but do not provide any support to the user to conduct the decision-making process. Figure 3.2 shows how TPS uses and produces data.

Fig. 3.2 Transaction Processing System

TPS is also termed as data processing system with authority at the lowest level in the management hierarchy of an organization. Transactions in TPS can be both internal as well as external in nature. External transactions are the transactions generated by customers and suppliers, whereas internal transactions are generated within an organization.

3.4 DECISION SUPPORT SYSTEMS

Decision Support System (DSS) helps the senior management to take strategic decisions. Contrary to other systems, decision support system is developed with the objective of providing the users (top management personnel) with unstructured information. This system helps the management to develop the 'what if analysis', so that different scenarios can be developed for decision-making. Decision support systems deal with both internal and external data. Usually, this system is custom-built with features like business dashboard, scenario panel, and so on.

This system is complex with models (internal) working on the data to provide senior managers with decision support. Unlike the transaction processing system, this system is not query-dependent. Its main role is to access data from a data repository and then pass that data through a model (mathematical, heuristic,

statistical, econometric, operations research, combinatorial, etc.), so that the top management can take better decisions by doing either the 'what if analysis' and scenario building or by doing 'predictive analysis' to get some insight into a business issue. This system is very costly to build and requires advanced analytics tools.

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Overview of DSS

The use of computers to solve complex analytical problems can be traced to the early days of computing in the 1960s[1] and became an established field of work for facilitating management decision-making (Michael S. Scott Morton, 1971). This class of systems loosely clubbed as Decision Support Systems[2], changed the way in which MIS was conceived in those days (Gordon Davis, 1974) and together with the work of Little (1970)—who observed that the biggest obstacle with management science/operations research based models was that people at the decision-making stage rarely used them and thus incorporated models inherently in such systems—laid the foundation of today's DSS. The framework for decision support[3] was, however, laid much earlier by Gorry and Scott Morton (1971), and also in the seminal works of both Herbert Simon (1977) and Robert N. Anthony (1965).

DSS is required when we have to take decisions on unstructured and semi-structured problems. This means that the problem itself is not clear, implying that a lot of ambiguity is present in the problem and its possible decision path outcomes. Such decisions are often required to be taken by the top management. In such cases, a lot of judgement, experience, intuition and expertise are required to take decisions as one is treading an uncertain path. No precedent is normally available for such decisions. A decision support system is required in such a case. A DSS is an information system class which assists in decision-making as described above. The system is robust and allows the user to create a host of alternative decision paths by analysing its data (internal data of the organization stored in a transaction processing system as well as external data), and then suggests the 'best fit' solution for the problem at hand. It prompts the decision-maker to take the best solution, but does not decide on the decision-maker's behalf. All the while, the DSS helps the decision-maker by providing him with supporting information about each decision path and is very interactive. The easy-to-use user interface hides the layers of model housed in the system and the user stays oblivious to the complexities of the system. It must be pointed out that the decision-maker has control over the process of decision-making, and makes choices at each stage of decision-making like choosing the database. The interactive nature of the system helps the decision-maker maintain control over the decision-making process. The system only works on data and provides alternatives to the user and also hints at the best pos sible solution. According to Gorry Scott Morton (1989), decision support systems 'couple the intellectual resources of individuals with the capabilities of the computer to improve the quality of decisions. They comprise a computer-based support system for management decision-makers who deal with semi-structured problems.[4]

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Components of DSS

Even though DSS can be of several types, fundamentally, each DSS will have the following components:

- **Interactive User-System Dialog Management Subsystem:** DSS requires continuous user interaction. Sometimes, the system should prompt the user to give an input; at other times the user should be able to control the processing. A typical user-system dialog management subsystem will have the following elements:
  - ***User Interface:*** The user interface of a DSS has to be dynamic and GUI-based. It has to be an easy-to-use user interface, as most users are not technical experts but management experts (top management) and hence the interface should be minimalist in design. Also, the system should be able to interact with the user in an interactive mode and hence, the user interface has to be dynamic.
  - ***Request Constructor:*** Since DSS works on an interactive dynamic mode, it needs a request constructor (incorporating aspects of Language Query Interface) which can convert the user's instructions into a model understandable form, and send the model's data request to the database, and the model's instructions/requests to the user.
- **Data Management Subsystem:** Data is the most important component of a DSS. Without data a DSS cannot function. The data management subsystem manages the data for a DSS. Data is accessed in a DSS in many ways such as: ad hoc basis, structured query basis and heuristic search basis. Hence, a strong data management subsystem is required to service the varied data requests from a DSS. The subsystem has the following elements:
  - ***Database Management System:*** It is the data store for the DSS. It manages the data and performs all functions that a typical DBMS package does. In fact, in most DSS, a commercial DBMS or RDBMS package is used to perform this task.
  - ***Query Control:*** This is an element tailored to handle the query requirements of DSS. It may connect the database directly to the user interface or to the model base or both.
  - ***Meta Data:*** This contains data/information about the data that is stored in the database. This helps the DSS in understanding the data in the database properly and helps in creating ad hoc queries.
- **Model Management Subsystem:** This is the unique feature of a DSS that makes the system special. However, this also makes the system very specific. There are very few examples of a generalized DSS, as generalized models are not available. Those that exist, work on half-baked solutions. The model management subsystem may use different classes of models such as:
  - Optimization models.
  - Simulation models.

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- Heuristic models.
- Deterministic models.
- Predictive models.

Each class of model is used to solve a specific class of problem like (say) a routing problem or a scheduling problem or a combinatorial search problem. Model and model management has several connotations in DSS literature and there have been wide-ranging definitions of these terms. The common strain that evolves from the plethora of definitions is that a model is conceived to consist of a solver and a model for solving a problem and data (Ramirez, 1993), where model represents relationships between variables, data represents the values of the variables under consideration and the solver is the tool that enables the computation of the variable values and their relationships. It has also been conceptualized in some literature as a procedure which works on the data to give an output after analysis.

The model management subsystem has the following elements:

- **The Model Base Management System:** A model base or rather a model base management system is a software (is conceptually like what the DBMS is to data) which has the capabilities to manage a model for it to be useful to the decision-maker. It is the core of a DSS. It supports the generation of models and works with data on one hand and user-supplied instructions on the other.
- **The Model Command Processor:** It is the entity that processes the commands coming from the dialog management subsystem.
- **The Model Executor or Solver:** It is the heart of the system. It is the process through which the model is solved (using some algorithm). It works with the model as generated by the model base (with instructions from the user), the request constructor (dialog management subsystem in general) to get the parameters of the model from the user and data from the data management subsystem. It then solves the problem and displays the results and some variations of the best fit solution through the dialog management subsystem. The alternative solutions, as provided, help the user in decision-making.

MIS and DSS

A DSS is different from an MIS. An MIS is used for generating consolidated reports. Generally, these reports are in a fixed format and generated at a regular frequency. When an MIS is designed, the reports it is required to generate are decided a priori and become part of the MIS. If a user wishes to generate an additional report, the system analyst may be required to modify the MIS. However, a sophisticated MIS may not require intervention for generating an on-demand report. Most MIS are Web-enabled and provide Web interface. An MIS can also generate exception reports to highlight deviation from the set targets. The target figures are input to the MIS that may be changed periodically. To give an example, sales target for a mobile cell company for December may be 1,00,000 new connections, whereas this figure may be 80,000 for January. The manager of

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this company would be interested in knowing zonal/regional sales, the plans that sell well/not so well, etc. based on the set targets.

In contract, a DSS helps in non-structured and semi-structured decisions. The objective of a DSS is to help the decision-maker in analysing the situation using the available data. The analysis may be required to predict future patterns, study the impact of parameters on future patterns, etc. A manager may like to increase sales and his options may be to increase the advertising budget, add more sales force, set up more sales offices or reduce prices. In terms of Simon's decision-making model, the problem is to increase sales and the aforesaid solutions are possible choices. In order to choose a solution, the manager would have to analyse each solution using possibly different analytical tools. Once a solution has been chosen for implementation, one has to monitor its impact. One can categorize a DSS based on the analytical support it provides.

Types of Decision Support Systems

A manager makes use of organizational data as well as external data for trend analysis. The external data may come from a marketing company involving competition, etc. There are two basic types of decision support systems: model-driven and data-driven. A model-driven DSS deploys a standard model to analyse data. The user provides data to the system in a pre-specified form and the DSS creates a parameterized model. A regression model, for example, assigns weights to all free variables such that the variance in the bound variable is captured. A manager can vary these weights to study the impact of changes on the bound variable. Model-driven DSS have a strong theoretical model embedded in them.

A data-driven DSS focusses on data and on retrieving some interesting, previously unknown and useful information from the data. Such systems are semi-automatic and require human intervention. Data mining techniques form a major percentage of data-driven systems. Data mining techniques are used for retrieving the following types of information:

Associations: The most common use of association discovery is in the market basket data analysis. A store would like to find out the items that people tend to buy together so that these items can be shelved accordingly or introduce a promotional scheme on one item only. The strength of the system is that the user does not have to specify the items at all. The data mining system analyses sales data and retrieves this information.

Sequential Pattern Identification: Such systems are used for identifying association over time; for example, if one buys a camera, he is likely to buy a tripod in the next one month. But the user does not have to specify the items or the time frame. It is the responsibility of the data mining system to discover these sequences. Notice that if one knows the items and the time frame, it is a simple database query.

Classification: Let us take an example: A bank receives an application for a loan and the loan manager wants to classify the application as a potential risky loan or good loan application. A data mining classification system will look at past applications and identify the parameters as well as values to propose a classification

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system. The new application data is entered into the classification system for classification. There are numerous applications in the business world of classification systems.

Data mining systems use statistical techniques, genetic algorithms, analytical hierarchy processes and heuristics/rules-based systems. Let us look at the components of DSS in detail.

DSS Applications

In this section, we will list some of the applications of DSS. Banks use classification systems to categorize a loan application as potential good or bad loan. A major mobile company in India does similar analysis to identify customers who are likely to switch service providers. Marketing departments may use a classification system to identify volatile customers and promotion schemes for them. Indian Railways has analysed passenger reservation data to upgrade to high class policy for passengers. Their analysis had shown that higher class seats remain unoccupied and many lower class passengers are not able to travel. Shifting some passengers to higher classes without extra charge brings in revenues for seats at a reduced rate which is better than no revenue at all; it leads to better utilization of resources and convenience to passengers.

Airlines use statistical models to forecast passenger traffic based on their past traffic, carrying capacity and traffic growth pattern.

All major projects go through scheduling and planning. The project manager estimates the time and cost of various activities involved in the project. If similar projects have been done in the past by the organization or some other organization, past data is analysed to estimate most likely, optimistic and pessimistic time for each activity and the whole project. Such analysis helps the organization plan the project much better.

You are probably aware that the Indian Railways schedule goods trains and their routes dynamically based on the demand. A scheduling system has been put in place after considerable effort whose objective is to minimize delays and maximize returns. Companies, such as Big Bazaar that carry a large number of products and have multiple stores across the country use DSS to decide order quantity and reorder point to maintain optimum inventory levels. A restaurant can use a decision support system to rearrange tables to maximize revenues and minimize customer waiting time. Dynamic pricing or promotional schemes may be introduced to shift some of the peak period demand to off-peak periods. Blood banks face a situation where they do not know the location and demand for blood in advance. They use a probabilistic model to decide storage location for blood. A similar problem is faced by manufacturing organizations. They use a similar model to decide the product mix for manufacturing to maximize revenues. Applications that we have just described are model-driven systems.

A software company analyses network traffic to identity patterns that may correspond to hacking, etc. There is no fixed pattern that corresponds to hacking. Normal traffic is observed and any change in the traffic pattern has to be picked up as a potential hacking attack. Such applications are data driven. Credit card companies use classification systems to identify potential customers.

Role of DSS in Business

Applications of DSS

DSS helps in various application areas to a large extent for the top management support, training of managers and variety of decision-making situations. The areas of applications of DSS in production and finance are:

- **Production**: DSS helps in various areas of production, such as cost estimation and analysis, production planning and scheduling, making or buying product decisions, inventory planning and control of manpower.
- **Finance**: DSS helps in various areas of finance, such as capital budgeting, financial planning and analysis, tax planning, strategic financial planning, budgeting, cash and working capital management, debt and equity financing analysis, foreign exchange risk management, financial performance analysis and variance analysis.
- **Future Decision-Making**: DSS helps managers to activate simulation models to access the required information from the database for decision-making. The simulation model is an interactive activity where the manager can experiment and see projected results for the planned action that are to be implemented in future.

Interactive System for DSS

Interactive system for DSS helps a decision-maker to evaluate the result of a particular course of action to solve a business problem. If a shortcoming exists in the solution, then the decision-maker can modify the solution or try for another solution.

In this way, interactive system of DSS helps in providing the best solution to a particular problem that can be applied in the concerned department of the organization. Interactive system for DSS is created using various query and high-level programming languages, such as SQL, COBOL and FORTRAN.

These languages prompt and help a user to make commands to retrieve the information with a user-friendly interface.

Modelling in DSS

In any business, all the decisions that are taken can be divided into two groups — programmable and non-programmable. A programmable decision is one which can be simulated by a computer. In case of a non-programmable decision, the rules on which they are based keep on changing depending on the internal and external environment of the organization, such as government regulations and macro-economic situation of the country.

A decision support system helps us in taking a programmable decision only, as it is based on simulation technique. A decision support system can take various approaches which can be categorized into three categories of models. These three categories are mentioned as follows (refer Figure 3.3):

1. Behavioural Models.

2. Management Science Models.
3. Operational Research Models.

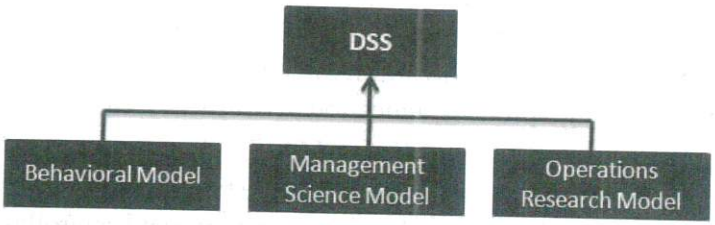

Fig. 3.3 A DSS System

1. **Behavioural Models:** *A behavioural model is an explicit statement of variables that impact the observed actions of a system of objects or a specific object or entity* (Daniel J Power). It refers to that category of DSS models that are based on the logic of understanding, explaining and predicting the behaviour of business variables. Most of the models of this category are based on statistical tools of analysis or mathematical equations. Some of the models that fall in this category are:
   a. ***Market Research Model:*** A market research model analyses the information gathered in any market research by using statistical formulas, such as variance, correlation, testing of hypothesis, etc.
   b. ***Time Series Analysis:*** This is an essential model which uses data from the past records to forecast variables like demand of a product, cost of living index in a city or country, etc., by reducing the seasonality effect.
   c. ***Regression Model:*** This model essentially uses regression method for business forecasting variables, such as sales of a product. Regression is a tool for statistical analysis which quantifies a relationship between uni or more independent variables and a dependent variable.
2. **Management Science Models:** All the DSS models that use the tried and tested principles and techniques of various functions of business management fall in the category of management science models. Most of these models are used directly for the design of decision support system. Some of the examples of management science model have been discussed below.
   a. ***Budgeting Model:*** This model is used for planning, preparing, monitoring and controlling various budgets like annual budget of a company, sales or promotional budget, budget of an event, inventory budget, capacity budget, production budget, etc.
   b. ***Return of Investment Analysis:*** Any business would like to calculate the return on each of its investments. This model gathers required financial data, such as investment, inventories, sales, bills, receivables, etc., and uses the financial equation of ROI (Return on Interest) to give the result.
   c. ***Cash Budgeting Model:*** Cash budgeting model helps a finance manager in assessing and planning the liquidity condition of the company.

d. ***Break-Even Analysis Model:*** This model gives the volume of production and sales that a company should reach so that its fixed costs are met and it starts making profits.

e. ***Cost Accounting Model:*** This model analyses data to give information like total cost of acquisition of an asset, cost of manufacturing or purchasing a product, allocation of overheads, etc.

f. ***Project Planning and Control Model:*** This model uses the project management techniques to assess the time required to finish a task/ project, thus helping in planning, monitoring and controlling them.

g. ***Procedural Models:*** These models are based on very simple mathematical formulas to arrive at critical results, such as reorder level of inventory or optimum order quantity. This category also includes models with simple process decisions, such as vendor selection (by purchase department) or candidate selection (by HR).

3. **Operational Research Models:** Operational research models is the category of mathematical models which use tools like algebra, probability, calculus, etc. in analysing the problem and giving the solution. They necessarily use practical assumptions of real life situation to arrive at a conclusion or solution. They are essentially used in production management or project management. Some operational research models are:

   a. ***Linear Programming Model:*** This model essentially uses linear programming equations to calculate the optimum allocation of various resources, such as raw materials, manpower and production capacity of the factory. It calculates the quantity of each of the product that needs to be produced to maximize the profit of a manufacturing company.

   b. ***Inventory Control Model:*** The tools like ABC analysis are used in this model to ensure that stock of inventory can be reduced to the minimum to ensure better liquidity and at the same time the company does not run out of critical inventory items.

   c. ***Material Requirement Planning Model:*** This is another model to help in the area of material management and is used to minimize inventory cost. This is a relatively simple model which is used in companies which have standard products and hence each bill of material can be mapped against a product for which it was used. This is especially used when there is high seasonality factor in the demand of the product.

Out of all the models that discussed above, the ones that are based on mathematical or statistical calculation indicate a definite decision that should be taken whereas the models which are based on principles of management form a basis on which the decision can be taken. In short, they are helping to improve the quality of decision that is to be taken.

Use of DSS Technology for Marketing, Finance, Production and Human Resource Management

A large organization has enormous in flow of data. Data has an extensive usage and is not restricted to a single channel, for example, each department maintains

the attendance of the employees working in their department. HR needs attendance related data to prepare the payroll while the finance department needs the payroll information for disbursement of salaries. Similarly, projections of production are made by a production manager. The data is put to multiple use by different executives. Marketing manager needs this information to base future sales target for his team, for planning the time and budget allocation for promotion of a new product. Similarly, the data related to inventory of raw material, work-in-progress and finished goods are maintained by the production department. The same data can also be used by the finance department at the time of preparing quarterly or annual balance sheets.

Thus, any organization needs a seamless flow of data from one department to another. If data is entered into the system at one section or department, it should be available for analysis and used by the other department without having to enter it again. To accomplish and maintain networked flow of data among various departments, one needs an integrated system, such as a DSS based on Enterprise Resource Planning (ERP).

Enterprise Resource Planning (ERP) is an enterprise-wide information system designed to coordinate all the resources, information, and activities needed to complete business processes such as order fulfillment or billing.

An ERP based decision support system assists in the amalgamation of managerial cadres, workforce and infrastructure. An ERP based decision support system has a distinct ability to coalesce different business units into a single system so that it could cater to all business facets. Thus, it gives a holistic view of the organization.

ERP software essentially has the following features:

- **Single Database:** An ERP software is integrated on a single database system. All applications use the same database for data input and retrieval.
- **Integration of Applications:** It is an integrated set of various business applications that includes accounts and finance, marketing, human resources, production, etc.
- **Integration of Internal and External Applications:** It integrates the internal applications of an organization with external applications to help access the databases of a supplier and customer.
- **Automated Business Transactions:** In an ERP system, business transactions, such as calculations of schedules of production, forecasts of demand, inventory level, production cost, cost of acquisition of an asset, etc., are automated to reduce manual intervention.
- **Report Generation:** ERP has automated recording, monitoring and report generation features to facilitate the process of decision-making.
- **Relational Database:** It is based on relational database that integrates data inputs, transactions and output coming from various departments and management functions.
- **Information Sharing:** Transactions that are taking place may be shared at any other place in an ERP-driven business. Each of the users can share and use data available depending on the rights that a person has.

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- **Modules with Automated Analysis:** An ERP based decision support system consists of various modules which are automated to do a variety of tasks, such as analysis, forecasting, planning, scheduling and reporting.

There are a number of advantages of using an ERP based decision support system in an organization. Some of these advantages are listed as follows:

- **Integration of Data Across Departments at Various Geographical Locations:** In an ERP-driven business, integration of data can be done over various departments located at different geographic locations, hence it is helpful when an organization has various departments spread across various geographic locations.
- **Data Accuracy:** Since data is entered only once, it reduces the probability of errors.
- **Improved Communication:** An ERP based decision support system ensures easy enterprise-wide information sharing. This leads to swift communication among various management functions and hence increased productivity and efficiency.
- **Better Analysis and Reporting:** An ERP based DSS has the facility of producing multiple reports for better analysis, planning and decision-making.
- **Use of Best Business Practices:** ERP based decision support system uses the best business practices followed across all industries. Since they are tried and tested time and again, they offer high reliability through proven performance.
- **Fast Implementation:** As the information is available online, implementation becomes easier and faster for policies, projects or performance targets.
- **Data Security:** Security of data of an organization is the responsibility of the ERP vendor who places data at different geographic locations. Hence, the data of all the organizations using ERP based decision support system is secure.
- **Maintenance:** The maintenance of the ERP system is also the responsibility of the ERP vendor. Hence, there is no time wasted in debugging software errors, etc.

SAP (R/3) is the leading ERP vendor with a huge market share of 28.4 per cent. It has a broad variety of applications for functions like finance, business intelligence, customer relationship management, supply chain management, product life cycle management, e-markets, portals, finance, human resources management, manufacturing, project management and planning. SAP was initially developed as a client server based software R/3. However, it is slowly changing into Web server based architecture with the name mySAP.com.

Use of DSS in Marketing

According to the American Marketing Association, *Marketing is an organizational function and a set of processes for creating, communicating and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stakeholders.* In simpler words of Philip Kotler, Marketing is *satisfying needs and wants through an exchange process.*

Marketing essentially includes the process of identification and satisfaction of customers' needs and wants in a manner that is profitable for the business. A marketing manager is responsible for taking tactical decision related to branding, product launch, planning of advertisement budget, decision on product mix, revenue forecasting, product cost optimization, pricing, optimizing product mix, customer and channel promotion, and monitoring market share changes.

An ERP based decision support system in marketing is an information system that facilitates the decision-making process of formulating a market plan. It helps brand managers make pricing, promotion, advertising, sales effort, and budgeting decisions for products, product lines and brands of all products. It can forecast sales and make estimates of profitability using internal and external data regarding customers, competitors, retailers, and other market information. There are various models of an ERP based decision support system which perform the following functions to facilitate the decision-making task of a marketing manager.

- It helps the manager to cope with information overflow by combining information sources giving similar information and by increasing the speed and ease of data access.
- It helps in experimentation with various marketing mix strategies and analyses the effectiveness of different scenarios.
- It analyses marketing related data to do necessary business forecasts, such as market demand, etc.
- It allows creation of scenarios and hence quicker assessment of available alternatives for making quality marketing decisions.
- It supports 'what-if' analysis with the help of graphical as well as descriptive interpretation of information that is available from the database.
- It helps in monitoring the performance of a sales team over the period of time.
- It supports the fast solution of complex and semi/unstructured problems and hence allows marketers to make objective and consistent decisions.
- It is a flexible and adaptive tool which allows addition, deletion, combination and rearrangement of basic elements to provide fast response to unexpected situations.
- It provides a research tracker database system, necessary for marketing research industry.
- It provides business consulting, including specialized consulting for non-profit organizations.
- It helps in creation of consumer connection database system for consumer durable goods manufacturers.

Marketing managers are more inclined towards SAP R/3 sales and distribution, and CRM (customer relationship management).

Use of DSS in Financial Management

Allocating financial resources to areas that generate a major chunk of funds is what financial management attempts to do. In the words of Steven Berger, *Financial Management is strategizing the organization's financial directions as well as the performance of its day-to-day financial operations.*

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In any stream of business, management of finances is an integral and crucial part. A finance manager would like to know the current cash flow situation, balance sheet, income and expenditure statements of the company. Each time you wish to perform financial calculations, such as current ratio (an indication of a company's ability to meet short-term debt obligations), return on investment, return on sales (the profit margin on the sale), tax and interest burden on the company, etc., you have to manually calculate.

An ERP based decision support system in finance is a class of systems which analyses crucial financial data to support the process of decision-making in financial activities. It is a flexible and interactive tool that gives updated financial statements and other crucial information to a finance manager from time to time in order to assist in making intelligent and informed decisions. An ERP based DSS for financial management calculates Return on Investment which is an important financial ratio is as follows (refer Figure 3.4):

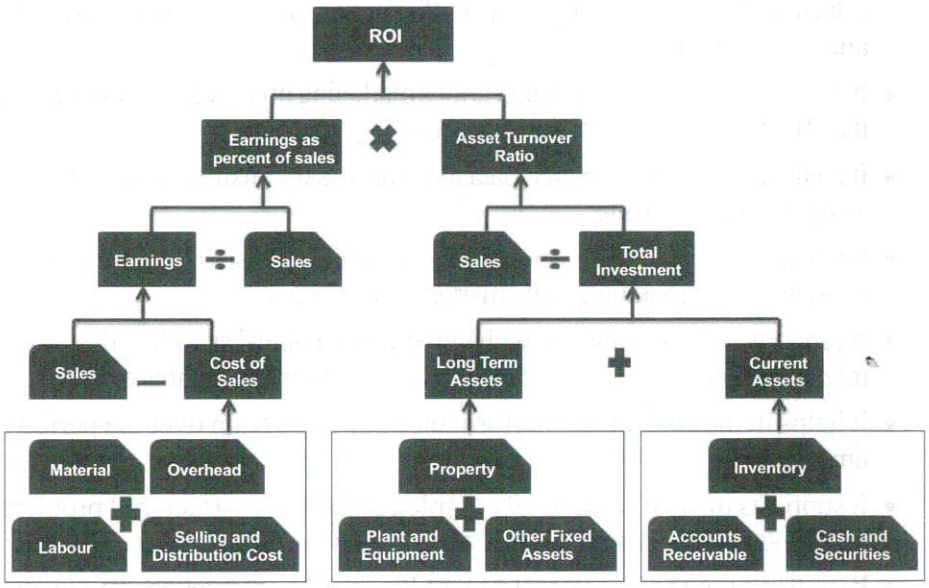

Fig. 3.4 ROI Calculation

The earliest sector to use financial decision support systems were financial institutions, such as banks, mortgage lenders, credit card companies, and investment advisors. The participation of the financial institutions was primarily to understand customer needs, preferences and behaviours. Earlier, they struggled with enormous data of customers which were located in incongruent folders with different layouts. Managing such high volumes of data was a complicated task and needed automated data gathering and analysis tools. This became possible after the recent advancement in information technology when database technology and data mining techniques were used to develop such tools.

A decision support system in finance has high impact on the profit margins of a company as it does the following functions:

- It provides online availability of funds position and balances. It instantly calculates more than a dozen important aspects to indicate the financial health of a company. A typical decision support system in finance could

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easily calculate ROE (Return on Equity), ROI (Return on Investment), debt to equity ratio, ROA (Return on Asset), profit margin on sales, company's growth rate, current ratio, quick ratio (an indicator of company's short-term liquidity), etc., to name a few.

- The payroll module of an ERP based decision support system in finance helps in writing paycheques, setting rates at which each employee needs to be paid, tracking the number of hours for which a person worked in a day, month or year and maintaining paperwork.
- It helps in recording, classifying, summarizing, analysing and reporting on the financial transactions of the organization.
- It gives managers the ability to analyse present market and economic trends to forecast the future trends and make informed decisions regarding the business and its operations. It warns the management against future problems when there is a strong deviation in financial results from historical patterns, or where the ratios warn about problems in the future. Hence the management can intervene at the right time.
- Day-to-day record-keeping is automatically done by the accounting module.
- For any new business opportunity, it does the cost-benefit analysis. The cost associated in taking up a business venture is deducted from the total benefits (forecast) to give the profit in venturing into a new line of business.
- By using financial auditing module, it protects the company's employees, investors and owners from any kind of accounting fraud. It also ensures that the company's internal controls are properly set up to prevent fraud.
- It allows for careful financial planning and tax planning. When there is change in profit of a company, cash and non-cash outlays need to be controlled accordingly, changed tax liabilities need to be calculated and cash flows need to be maintained positive throughout.
- If there is no continuous monitoring, a company may end up in debt trap or liquidity crunch when it is taking up one loan to repay another. With a decision support system, the finance manager knows the amount of loan that the company can take, for how long (for which maturities) and at which interest rate.
- It forces the top management to rationalize the policies related to depreciation, inventory and inflation.
- It can easily compare the financial health of a company with its competitors or among various divisions or lines of business.
- It can indicate the production department about the amount of inventory the company can hold without losing on liquidity front.
- For a company investing in stock market, it studies the fluctuant, non-linear and chaotic characteristics of the stock options and helps avoid manual errors during analysis.
- It is not possible to analyse the portfolio of a company at any point in time However, this has become possible with the portfolio management tool in DSS.

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Use of DSS in Production

Production management refers to application of management functions to the Production in the factory. It is the job of coordinating and controlling all the activities required to make a product.

Production managers are concerned with taking critical decisions like diversification of product, assessment of product quality, assessing optimum production level and product mix, optimum stock level and reorder level, etc., in the shortest possible time. They are constantly working towards increasing efficiency of operations by reducing cost and lead time and improving the quality.

A decision support system became a necessity for many organizations after the number of products they manufactured went high. This was also the reason why decision support system in production function was among the first to be developed. Hence, it is quite comprehensive in its application to production or product management. An ERP based decision support system in the area of manufacturing is especially developed for supporting the solution to management problems which are not properly defined and structured. Most of the time, manufacturing decision support system and production decision support system are used interchangeably.

ERP based decision support systems in manufacturing help the process of decision-making in the following ways:

- Optimally plan, implement, schedule, sequence, and supervise all processes of production.
- Identify and solve exceptions and deviations in performance in an economical way and in real time.
- Institutionalize lean manufacturing and six sigma processes and monitor production to drive continuous improvement.
- Develop members of staff efficiency and build a superior class job atmosphere.
- Capturing, management and analysis of production related data becomes easier especially in very large production houses.
- It tracks and matches the purchase order, inventory receipts and invoices generated by the vendors. It also helps in order tracking from the time of acceptance of an order till order fulfilment.
- It maintains the revenue cycle from invoice till cash receipt.
- Use of data related to past trends in production and forecasting techniques instead of partially informed, intelligent assumptions to predict about future production needs.
- Coordination of operations with partners and suppliers and coordination of all the elements of production to increase in overall utilization of a factory's production capacity, particularly in case of a complex system with multiple product manufacturing.

- In case of a company having more than one product, it can decide the optimum mix of the product using linear programming technique which uses cost of each of the inputs (stock, manpower as well as time) in those products.
- It helps in deciding the optimum order quantity and reorder level for each of the stock item using inventory control tool.
- In case the production requirement is fluctuating from time to time, it helps in planning, procurement, monitoring and control of inventory.
- The quality related module has the ability to assess the impact of any changes in the quality level due to each defect in any of the products. Hence, it helps in meeting quality parameters expected by the customers.
- It uses techniques like PERT (Project Evaluation and Review Technique) and CPM (Critical Path Method) to help a project manager in planning, scheduling and controlling the time required in finishing a project.
- Complies with environmental, health and safety standards.
- Keeps a record of production decisions taken for future reference.

Six Sigma: A systematic method for improving the operational performance of an organization by eliminating variability and waste.

Linear Programming: A mathematical technique used to obtain an optimum solution in resource allocation problems, such as production planning.

Project Evaluation and Review Technique: The Program (or Project) Evaluation and Review Technique, commonly abbreviated PERT, is a model for project management designed to analyze and represent the tasks involved in completing a given project. PERT is a method to analyze the involved tasks in completing a given project, especially the time needed to complete each task, and identifying the minimum time needed to complete the total project.

Critical Path Method: Abbreviated as CPM, a project management technique that analyses what activities have the least amount of scheduling flexibility (i.e., are the most mission-critical) and then predicts project duration schedule based on the activities that fall along the 'critical path'. Activities that lie along the critical path cannot be delayed without delaying the finish time for the entire project. Projects planned with CPM typically are graphically represented in a diagram showing how each activity is related to the others.

The most widely used ERP based DSS for manufacturing is SAP R/3, which has specific modules like production planning, material management, quality management and supply chain management.

Use of DSS in Human Resource Management

Human Resource Management (HRM) is the strategic and coherent approach to the management of an organization's most valued assets — the people working there who individually and collectively contribute to the achievement of the objectives of the business.

A manager of human resources is responsible for functions like workforce planning, recruitment, induction, training and skill management, compensation and payroll, employee welfare administration, performance appraisal and promotion

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and attrition. An ERP based decision support system collects and analyses data to assist in making decisions related to human resources.

A decision support system for human resource management can help an HR manager in the following ways:

- Assists in the selection process when the HR manager is taking personnel job interview by providing useful suggestions after evaluating different characteristics of a candidate.
- Evaluates the experience and skills of all the candidates and matches them with the requirements to choose the one who best fits in that particular role.
- Generates HR related reports that may contain both details and summaries of employee population, compensation, turnover rates, and other elements of human resources management.
- Keeps a record of all employee details, their performance details and hence helps in capacity utilization of human resources by matching their knowledge and skills with that required in a particular profile.
- Keeps a current record compensation structures which allows to play around with percentage changes affected by different performance ratings.
- 'What-if' analysis helps to see the impact of increase in salaries on the total salary bill of the organization.
- Helps in analysing and reducing the discrepancy among the salaries of employees who joined at the same time, same level of hierarchy and performing similar tasks.
- Reduces the exception of various grade bands, designation bands, experience bands by analysing salaries in each of the bands.
- Facilitates development of HR policies and defines rules which makes it easier to make changes to the existing compensations of employees.
- Collects rules to help in writing employee handbooks which inform all employees about the policies and procedures of the organization.

In the category of ERP based DSS for human resource management, HR managers are mostly inclined towards PeopleSoft's HRMS (Human Resource Management System), SAP ERP HCM (Human Capital Management), Infor's HCM and Microsoft Axapta Human Resource Management III.

On one hand, ERP modules that are used under each of the functional areas help individual management functions for improving the decision-making process. On the other hand, they also help integration of databases so that they can be well utilized by other departments as well. This integration is the most important feature that is required by any multifaceted organization of modern times. It helps the top management to have a holistic picture of the state of affairs in the organization and forms the basis for making crucial strategic decisions. However, for effective implementation ERP modules need to be customized so that they can adapt to the specific workflow needs of individual industries. Then only they will be better utilized across the industries.

Decision Modelling Exercises

Decision Types

The decisions taken by an organization are different in many ways. These affect the development of alternatives and the choice available among the alternatives. The different decisions also affect the support provided by the design of an information system for carrying out decision activities. The decisions are classified on the basis of the following factors:

Purpose of Decision-Making

On the basis of the purpose of the decision-making activities, the organizational decisions are divided into the following three different categories:

1. ***Strategic Planning*** comprises the decisions in which a decision-maker develops objectives and allocates resources to achieve these objectives. The decisions in this category are of a long-time period and involve large investment and effort. Such decisions are taken by executives who are a part of the conceptual process and are at the helm of the corporate ladder. Examples of such decisions may include introduction of a new product and acquisition of another firm.
2. ***Management Controls*** are those decisions taken by the management control plan executives who are centrally placed in the corporate ranks. These managers deal with the use of resources in the organization. Analysis of variance, product mix and planning decisions fall in this category of decisions.
3. ***Operational Controls*** are the decisions for dealing with the day-to-day problems that affect the operation of an organization. For example, decisions, such as production scheduling and inventory control fall in this category. The product to be produced for the day or the items and their quantities to be ordered are operational control decisions. Such type of decisions are normally taken by executives who are at the lower level of the company.

Note: Due to the overlapping nature of some decisions, the boundaries for classifying decisions in these categories are not very concrete and therefore, these decision types should not be taken as discrete ones.

Programmability Levels of a Decision

According to the programmability levels of a decision, the decisions are of the following two types:

1. ***Programmed or Structured Decision*** refers to the decisions that are well defined and require application and implementation of some specified procedure or decision rule in order to reach a decision. Such decisions require little time for developing alternatives in the design phase. Programmed decisions are made by operating procedures or by using other accepted tools. More modern techniques for making such decisions involve operations research (OR), mathematical analysis, modelling and simulation.
2. ***Non-Programmed or Unstructured Decision*** refers to the decisions, which are not well defined and have no pre-specified procedure or decision

rule. These decisions may range from one-time decisions relating to a crisis, to decisions relating to recurring problems. The unstructured decisions consume sufficient time in the design phase of the decision-making process. These decisions can be solved using judgement and intuition. Modern approaches to such decisions include special data analysis on computers and heuristic techniques. Decisions of this kind are usually handled by strategic planning level managers. As a result of their unstructured nature, these decisions cannot be used as representatives for lower-level decisions and are difficult to automate. For example, planning for R and D is an unstructured decision.

3. ***Semi-Structured Decision*** refers to decisions that are neither structured nor unstructured. These decisions are supposed to fall somewhere between the structured and unstructured decisions. For example, introduction of a new product is semi-structured decision.

Note: There is no distinct line of difference or boundaries between the two types of decisions; rather they exhibit a continuum for the classification of decisions.

Knowledge of Outcomes

'Knowledge of outcomes' is another approach for classifying decisions. An outcome defines what is going to happen if the decision is taken or the course of action is taken. The knowledge of outcome plays an important role when you have more than one alternative. On the basis of the level of knowledge of outcomes, decision-making can be classified into three categories:

1. ***Decision-Making Under Certainty*** takes place when the outcome of each alternative is fully known and there is only one outcome for each alternative. In such a situation, a decision-maker is required to compute the optimal alternative or outcome.
2. ***Decision-Making Under Risk*** occurs when there is a possibility of multiple outcomes of each alternative and a probability of occurrence can be attached to each outcome. Such decision-making is also similar to the decision-making under certainty where instead of optimizing the outcomes, the general rule is applied to optimize the expected outcome. A decision-maker is assumed to be reasonable for choosing a particular decision. A decision-maker, for example, has to choose from the given two options, one offering a 2 per cent probability of a profit of Rs 1,00,000 and the other an 80 per cent probability of a profit of Rs 10,000. The decision-maker chooses the second alternative because it gives a higher expected value. This is explained as follows using the formula:

   Outcome × Probability = Expected Value

   $1,00,000 \times 0.02 = 2,000$

   $10,000 \times 0.80 = 8,000$

3. ***Decision-Making Under Uncertainty*** takes place when each alternative has a number of outcomes, and the possibility of occurrence of the alternatives is unknown. Optimization criteria cannot be applied for making these types of decisions because there is no knowledge of these probabilities. Decision-

making under uncertainty arises when different people in an organization take decisions by applying different decision rules. Some, for example, may assign equal probabilities to all the outcomes for each alternative, so as to treat the decision-making as decision-making under risk, whereas others may adopt different criteria, such as maximax and maximin criteria to minimize regret.

Methods for Choosing Alternatives

A decision-maker uses various methods for choosing the best alternative among the available alternatives. The methods that are used for choosing alternatives generally assume that all the alternatives are known.

Decision Theory and Decision Analysis

The decision theory and decision analysis refer to the techniques for analysing decisions under risk and uncertainty. In the process of decision-making, a decision-maker wants to achieve his goal, purpose or objective. The decision-maker chooses one particular alternative from various alternatives, which is termed as the 'strategy' of the decision-maker. All alternatives and outcomes are assumed to be known to the decision-maker. There are certain factors termed as 'states of nature', which affect the outcome for different strategies. The strategy or alternative, along with the state of nature, determines the degree to which the goal is actually achieved. This measure of achievement of the goal is termed as 'Pay-off'. The pay-off matrix is used as a method of presenting data in decision analysis. A pay-off matrix is a good representation of a decision problem because the alternatives available to the decision-maker are represented in rows, and the states of nature in columns. Each cell of the matrix, which is an intersection of a strategy and a state of nature, contains the pay-off. If the state of nature is known with certainty, then the the decision-maker has the option to choose the strategy providing the maximum pay-off. Figure 3.5 shows the pay-off matrix.

Strategies	States of Nature			
	N1	N2	N3	N4
S1		a ←		
S2				
S3				

Pay-off

Fig. 3.5 Pay-off Matrix

Assume, for example, that a marketing manager of a computer manufacturing company chooses from the following three alternatives:

1. Launch a new PC having latest technology.
2. Leave the PC as it is and do nothing.
3. Modify the existing PC to improve its design and processing power.

There are three states of nature that affect the pay-off from each of the alternative strategies. These states of nature are:

- Conditions remain the same as they are.
- A competitor may launch a new PC with the latest technology.

- The government may impose high excise duty on manufacture of PCs and reduce excise on laptops to encourage the use of laptops.

Figure 3.6 shows the various pay-offs from the combination of a strategy and a state of nature.

(Pay-off in lakh of rupees)

Strategies	States of Nature		
	Government Ban (0.20)	Same Conditions (0.40)	Competitor (0.40)
New Product (S1)	–13	10	3
Do Nothing (S2)	–2	5	1
Modify (S3)	–5	7	5

Fig. 3.6 *Pay-off Matrix Combining Strategy and States of Nature*

Each cell, which is an intersection of a strategy and a state of nature, contains the probabilities for the occurrence of each state of nature, either based on historical data or on personal judgement of the decision-maker. It can be seen that there are three states of nature with known occurrence probabilities. This problem situation is called decision under risk. To make a decision under such a situation, a decision-maker should compute the anticipated worth of each option. The expected value is determined by multiplying each pay-off by the probability of occurrence of the state of nature (given in columns) and adding these values across all states of nature (across the rows). In the above example, the expected value (EV) of strategy S3, is:

$$\text{EV of S3} = (-5)(0.20) + (5)(0.40) + (7)(0.40)$$
$$= -1 + 2.0 + 2.8 = 3.8$$

The maximum expected value, that is Rs 3.8 lakh, is found to be of strategy S3, which is to modify the PC. In addition, if the decision is made based on the expected value objective function, strategy S3 will be selected.

The decision-maker is aware of the probabilities of various states of nature while making a decision under risk. However, the decision-maker is unaware of the probabilities of the different states of nature in case of decision-making under uncertainty. Figure 3.7 shows the pay-off matrix for which the decision-maker does not have the knowledge of probability of occurrence of the states of nature.

(Pay-off in lakh of rupees)

Strategies	States of Nature		
	Government Ban (0.20)	Same Conditions (0.40)	Competitor (0.40)
New Product (S1)	– 13	10	3
Do Nothing (S2)	– 2	5	1
Modify (S3)	– 5	7	5

Fig. 3.7 *The Pay-off Matrix where Probabilities of Nature are Not Known*

Therefore, a decision-maker cannot apply the maximization/minimization of expected value criteria as in the case of decision under risk. In such decision problems, the following decision rules or decision criteria may be applied:

1. Criterion of 'minimize regret' refers to the selection of strategy that minimizes the maximum regret for each decision taken by a decision-maker. The decision-maker might regret if he is not able to select the appropriate strategy in terms of particular states of nature. The regret of the decision-maker is the difference between the highest pay-off for a state of nature and the pay-off for the other strategies for the same state of nature regret matrix. Figure 3.9 showing the regret matrix displaying minimum of maximum requests for strategy S3, which includes modification of a PC. The regret of the decision-maker is computed by subtracting the value in each entry in the column from the highest value in the column. The decision-maker needs to select the strategy that is going to give him the minimum of such maximum regrets. Figure 3.8 shows the pay-off matrix showing the differences between the highest pay-off for a state of nature and the other pay-off for the same state of nature.

Strategies	States of Nature		
	Government Ban	Same Conditions	Competitor
New Product (S1)	–2(–13) = 11	10 – 10 = 0	5 – 3 = 2
Do Nothing (S2)	–2–(–2) = 11	10 – 5 = 5	5 – 1 = 4
Modify (S3)	–2–(–5) = 3	10 – 7 = 3	5 – 5 = 0

Fig. 3.8 The Pay-off Matrix showing the Differences between the Highest Pay-off for a State of Nature and the Other Pay-off for the same State of Nature

Strategy	Maximum Regret
S1	11
S2	5
S3	3 ← Minimum of maximum requests

Fig. 3.9 The Regret Matrix

In the current case, the minimum regret is 3 lakhs. The decision-maker should select strategy S3, which modifies the product. This is the minimum regret, if all the other strategies available to a decision-maker are taken into consideration. But at the same time, 3 lakhs is the maximum regret, which the decision-maker experiences for strategy S3.

2. Maximax rule or criterion of optimism refers to the optimistic attitude of a decision-maker that enables him to select the strategy that is able to provide him the maximum pay-off under the most favourable condition. In this example, the decision-maker selects strategy S1, which gives him a maximum pay-off of 10 lakhs for launching a new PC. Figure 3.10 shows the maximum pay-off to the decision-maker by implementing the strategy S1.

Strategy	Maximum Pay-off
S1	10 ← Maximax
S2	5
S3	7

Fig. 3.10 The Maximum Pay-off Matrix

3. Criterion of rationality assumes equal probabilities of various states of nature and as a result, is considered a rational approach of decision-making. This criterion is also termed the Laplace Criterion. This criterion becomes the decision problem under risk after attaching the possibilities to the states of nature. After attaching the possibilities, the expected pay-off for each strategy is calculated and the strategy holding the highest expected pay-off is selected. In the example that we have been discussing, the expected pay-off for each strategy is given in Figure 3.11. The probability of each table is assumed to be equal to 1/3 since there are three states of nature.

Strategy	Maximum Pay-off
S1	1/3 (10 + 3 – 13) = 0
S2	1/3 (5 + 1 – 2) = 1.3
S3	1/3 (7 + 5 – 5) = 2.3 ← Highest EV

Fig. 3.11 The Expected Pay-off Matrix

Therefore, as per the discussed criterion, strategy S3 should be selected because of the highest expected pay-off.

4. The maximum rule or criterion of pessimism indicates that a decision-maker has a pessimistic attitude and therefore, selects the strategy, which gives him the maximum pay-off even if the worst condition occurs. Here, the decision-maker does not like to take any risk and as a result, thinks about the safest position in the worst situation. Therefore, the decision-maker selects strategy S3, since in the worst situation, which is the case of a government ban, the decision-maker sustains the minimum loss of Rs 2 lakhs due to this decision. Figure 3.12 shows the matrix for the minimum pay-off.

Strategy	Maximum Pay-off
S1	–13
S2	–2 ← Minimum Pay-off
S3	–5

Fig. 3.12 The Minimum Pay-off Matrix

Decision Tree

Decision tree is an important method for presenting the analysis of a project. It helps in displaying the graphical representation of a sequence of decisions and actions. The analysis of the project presented by a decision tree resembles the branches of a tree with the root of the tree as the starting point of the decision sequence. Figure 3.13 shows the decision tree sequence.

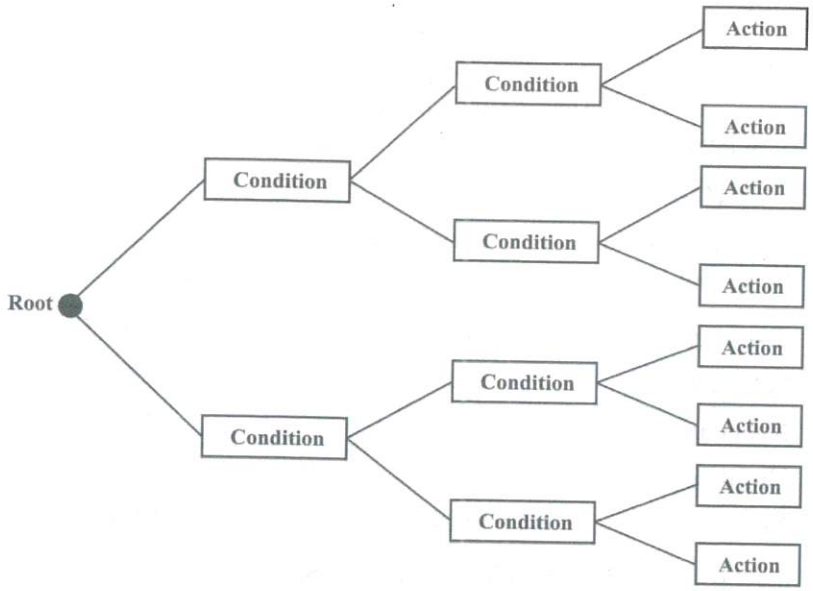

Fig. 3.13 Decision Tree Sequence

The function of a decision tree that helps in structuring the problem is composed of the following two options:

1. Problem structuring includes understanding the logical processing of a problem. Consider the case of a computer firm that offers the following discount policy to its customers.

   If the payment is made within a week,

   4 per cent discount is allowed on orders above ₹ 11,000.

   3 per cent on orders up to ₹ 6,001 to ₹ 11,000.

   2 per cent on orders up to ₹ 6,000.

   However, if the payment is made after a week, only 1 per cent discount is allowed.

   The above discount policy can be presented with the help of the following decision tree as shown in Figure 3.14.

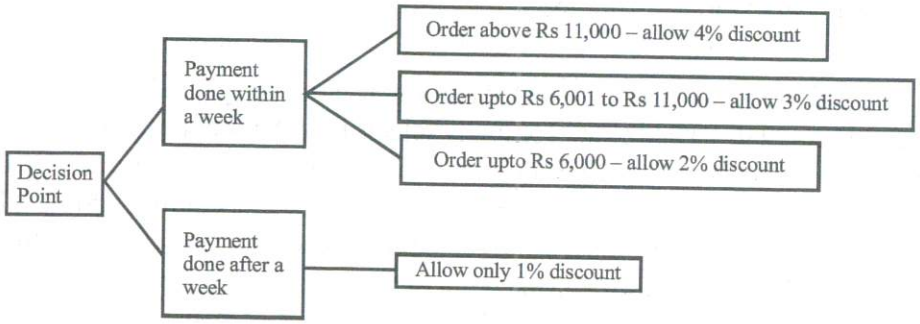

Fig. 3.14 Decision Tree for Discount Policy

2. Problem analysis includes the analysis of a problem. Suppose a company named ABC wants to take decisions for the distribution channel for the marketing of its products. The available alternatives with the company are:

   A. Selling agent

   B. Direct sales

   The company may have high or low market penetration and market share. The probabilities and net gains are as shown in Figure 3.15.

Channel	*Low Penetration*	*High Penetration*
Selling Agents	0.20	0.80
Net Gains	20 lakhs	80 lakhs
Direct Sales	0.40	0.60
Net Gains	30 lakhs	40 lakhs

Fig. 3.15 The Probabilities and Net Gain

Figure 3.16 shows the decision for the example as discussed above.

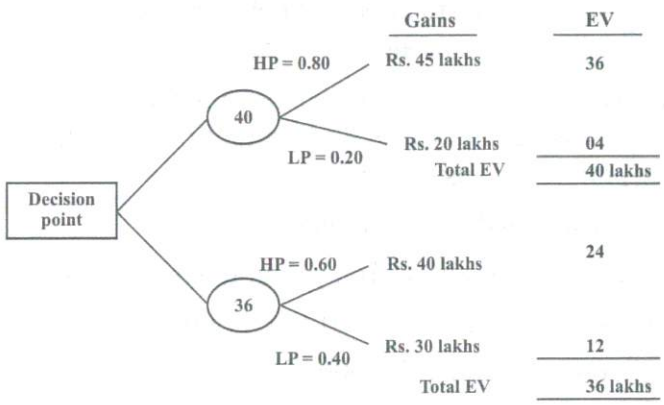

Fig. 3.16 The Decision Tree

Here, LP means low penetration and HP means high penetration:

Expected pay-off for selling agent = (0.80)(45) + (0.20)(20) = 40 lakhs

Expected pay-off for direct sales = (0.60)(40) + (0.40)(30) = 36 lakhs

Therefore, the decision taken by the decision-maker is as follows:

As the channel option selling through the agent would give a higher pay-off, which is equal to 40 lakhs, the company selects this channel for marketing its products. However, when large numbers of decisions need to be taken and each decision affects the subsequent decision, the rollback procedure is adopted. In this procedure, a decision-maker starts at the end of the branches and works from the back to the front till the decision point of the decision tree is reached. This is done to calculate the selected pay-off for all the branches of all the nodes of a tree. The choice of maximizing the expected pay-off on the whole is found by analysing the possible outcomes at each decision point.

Optimization Techniques

A number of optimization techniques, such as linear and dynamic programming are available for taking decisions during a decision-making process. Various other techniques in this category are integer programming, queuing models and inventory models. These optimization techniques assume that the decision-maker knows all the alternatives and the outcomes of the alternatives. All these optimization techniques are used by a decision-maker to reach an optimal decision to complete the objective of the function.

Decision-Making and MIS

The role of a management information system is important to understand the concept of decision-making. Decision-making concept is also used for designing an information system. The support that the management information system provides to the decision-making process in various ways is discussed as follows:

- ***Support for Decision-Making Process:*** MIS plays its role in all the three stages of the decision-making process as already covered in the previous segment. Following is the discussion of a decision-making procedure with respect to the role played by MIS at three phases of the procedure.
  - o ***Intelligence Stage:*** Internal and external feedback could be provided by the Management information systems. Internal information is generated from the functional areas but the external information is collected from various sources, such as newspapers and personal contacts. Availability of a large amount of information at this stage makes it necessary to scan the data sources to get the relevant information. As a result, the information system is used to scan the business environment of an organization.

    Procuring the required information from an intelligence phase that belongs to decision-making process, MIS must be designed so as to answer pre-specified and ad hoc queries made by a decision-maker. In other words, the information system design must have models, such as historical planning along with a query language capability that provide decision support capability for the system.
  - o ***Design Stage:*** Management information systems provide support by quantifying and automating a decision-making process during the design stage while considering structured decisions. At this stage, various alternatives are developed and evaluated. On the other hand, for semi-structured and unstructured decisions, the support of a management information system provides the abilities as follows:
    - To reach a decision in an interactive process, which includes decision support system capability
    - To make ad hoc queries for information in the organizational databases

    Therefore, information systems should be designed to incorporate various models of business operations and advanced statistical and optimization techniques. These techniques can then be used to manipulate information that is already collected in the intelligence stage to develop and evaluate various alternatives.

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- ***Choice Stage:*** Management information systems should provide summarized and organised information to the decision-makers at this stage of the decision-making process. It is the stage in which a course of action is selected and feedback is collected on the implemented decision. MIS also provides the feedback support to a decision-maker in case he/she wants to return to the preceding stages of the decision-making process in order to gather more information. Models, such as optimization and suggestion should be used to select the most appropriate alternative, which helps the decision-makers in selecting the best course of action.

Characteristics of DSS

The characteristics of DSS are as follows:

- DSS works in semi and unstructured environments rather than in a structured environment. In structured environments, DSS is not required as the problem (and environment) and information related to it is structured and available. In most cases, structured decisions have precedence and thus have a reference point. In unstructured and semi-structured environments, DSS is required.
- DSS plays a decision-support role – It does not replace the decision-maker but only helps the decision-maker to take a better decision by:
  - o Making more analysed data available.
  - o Processing the analysed data through a model and making available possible decision paths.
  - o Enabling him to conduct 'what if' analysis in a simulated environment.
  - o Helping him put up a realistic picture of outcomes.
- DSS can support individual users or a group of users – DSS can work in an individual as well as a group mode as per the needs of the organization. In case of group-based decisions, DSS can be tailored to work in groups.
- It supports all phases of the decision-making process.
- It focusses on effectiveness.
- It remains under the control of the DSS user unlike an expert system, which can take action on its own. It remains under the control of the user and functions as required by the user.
- Uses underlying data and models – DSS is useless without the underlying data, as most DSS work on an empirical platform rather than a theoretical platform.
- They can provide support for multiple independent or interdependent decisions.
- It has a model at its core which helps it to solve complex decision problems – the model is the heart of the DSS. It gives the DSS the capability to solve unstructured and semi- structured problems.

Framework for DSS

Herbert Simon laid out the most popular framework for decision support which consists of three linear phases—intelligence, design and choice. Van Grundy,

Mintzberg and others have later on modified this framework to suggest that decision-making, as an activity, was more complex to describe in a linear model and have gone on to give more comprehensive frameworks. These works led to the development of models on the framework of problem-solving. R.H. Sprague (1980) gives us a framework for DSS itself in which DSS is conceptualized as having three components—database, model base and a dialog management system.

A DSS works normally in a client–server or 3-tier architecture environment, where the client houses the model and interface, and the server houses the data. Many variations of this are possible. A schematic diagram of a DSS in a client–server environment is shown in Figure 3.17:

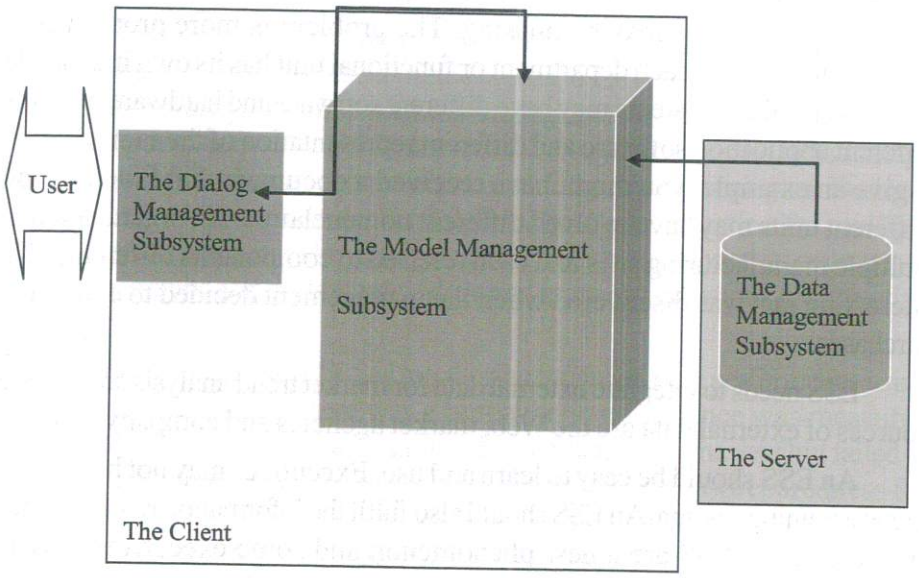

Fig. 3.17 The Decision Support System within a Client–Server Framework

Benefits of DSS

DSS helps the management to take decisions that are complex and difficult. It improves the quality of decision-making by helping the decision-maker to make informed choices. It thereby improves efficiency and improves performance. By expediting problem-solving (mostly at the upper levels), it frees the managers and helps them to concentrate on other tasks. Therefore, it helps the managers to become effective and manage their time efficiently. It enhances the quality of decision-making and thereby helps the organization to build a competitive edge.

3.5 EXECUTIVE SUPPORT SYSTEMS

Executive Support Systems (ESS) are designed for senior executives of organizations. Executives are responsible for the growth and survival of the organization. They need to monitor the performance of the organization, remain competitive and respond to market changes and trends, etc.

Role of ESS

How will an executive know the performance of the organization? The answer is very simple: by looking at the performance data. This data is stored in transaction

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processing systems in terms of current sales, purchases, expenses incurred, etc. An executive or manager would like to look at the consolidated data, targets set, performance of previous years and performance of the competitors. If he is interested in details of a particular product or zone, he would have the option of drilling down. There are two terms associated with executive support systems: roll-up and drill-down. Roll-up refers to consolidating data and drill-down is the ability to view expanded data. If, for example, sales data is available for an organization for sixteen zones, a roll-up may present data in terms of five regions and a drill-down view may present each product or each sales office, etc. An ESS provides a graphical view of the data. The most challenging part of building an ESS is to transform transactional data into usable form. The data may be incomplete or the required fields may be missing. The problem is more pronounced in organizations where each department or functional unit has its own independent TPS. Each of these systems may have different software and hardware platforms, different application software and different representation of the same data. Just to give an example, you might have received a document that failed to open. Different units may have evolved different nomenclature. An organization had multiple manufacturing sites and each referred to components differently. This interesting fact was discovered when the management decided to consolidate purchases.

ESS needs to integrate external data for market trend analysis and forecast. Sources of external data are the Web, market agencies and company reports.

An ESS should be easy to learn and use. Executives may not have time to attend a training session. An ESS should also fulfil the information requirements of the executives. ESS are a new phenomenon and some executives may feel uncomfortable using an ESS. It is easy to monitor the performance not only of the organization but also of colleagues. ESS are expensive as they are mostly custom built, integrate organizational and external data and provide graphical user interface and analytical capabilities. As with any project, ESS deployment also goes through a cost-benefit analysis. However, most of the benefits of information systems are intangible. Look around you: identify information systems that you use or see in use and try to enumerate benefits. Start with cell phones and you will soon discover that all benefits are intangible. Sometimes, it is difficult to justify investment in information systems. But in the last two decades, the scenario has changed and investment in information systems has increased.

Benefits of ESS

Executives in an organization are senior people who have years of experience behind them. These people have done well without ESS for long. Since the economy became global, business decisions have become global and require global thinking. The competition has also become global and employees also tend to move for better prospects. If there are no ESS to support decision-making, decisions are people-centric and the organization depends on its executives. In the present scenario, there is emphasis on putting systems in place to reduce dependence on individuals. Information systems help immensely in achieving this objective.

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Apart from these generic advantages of information systems, an ESS helps executives make decisions, especially the ones involving external data. Once a system to transform and integrate data has been put in place, managers can analyse data and view it according to their requirements.

An ESS increases the domain, span and capability of a manager to analyse data for trend analysis. It is not humanly possible to analyse a large amount of internal and external data. A by-product of deploying a centralized data repository is the introduction of organization standards.

ESS and Digital Firms

Business Intelligence (BI) has become the buzzword in every organization. Traditionally, a data warehouse store organizational data that may not be current and may have one or two days of time lag. The data was accessible to a select few. Most of the employees had restricted access to the data and few made use of the data. But nowadays, the emphasis is on using data intelligence to make small as well as big decisions. The performance of the organization and brand image depend on thousands of seemingly small decisions made by the employees. Business intelligence systems analyse data and deliver timely information for multiple purposes. Information may be disseminated through a graphical user interface using charts, graphs and dashboards. More and more organizations are investing in BI systems.

Another application of ESS is monitoring organizational performance using the Balanced Scorecard. There was a time when performance was measured only in terms of profits. An organization did well financially one year but failed to survive the following year. There were reasons, such as non-preparedness for future and being out of sync with changing market trends. Sometimes, even employees were not happy, committed and motivated. A balanced scorecard measures the performance of an organization on four axes: shareholders' view, preparedness for future, employees' view and customers' view. There are many software available in the market for helping an organization in implementing a balance scorecard.

An ERP system integrates all functions through a centralized database. Companies are performing add-on modules that use ERP data and provide data reports and data analysis tools.

The challenge is to identify the requirements and deploy an appropriate system. One does not have to invest in an information system just because it exists. There has to be a clear objective in investing in information systems.

Check Your Progress

1. What is office automation system?
2. Define the term transaction processing system.
3. What is DDS?
4. Write the use of DSS in marketing according to American marketing association.
5. What is Executive Support Systems (ESS)?

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3.6 EXPERT SYSTEMS

Expert systems offer an economical and practical way to capture, refine and proliferate management skills. These systems provide a framework in which to document the questions and answers that experts use to solve analytical and operational problems. With expert systems, the know-how of one 'expert' can be put in the hands of many workers to improve consistency, accuracy and productivity throughout the network.

An expert system program captures and stores logistics knowledge as rules (heuristics), policies, checklists and logic, in a 'knowledge base' in much the same way a conventional computer programme stores numeric information in a database. As a result, expert system programmes tend to be much easier to modify, update and enlarge than conventional computer programmes.

Logistics expert systems are applied where expertise can increase the firm's return on assets. Applications include carrier selection, international marketing and logistics, inventory management and information system design.

Expert systems include three components: knowledge base, inference engine and user interface. The knowledge base contains the expertise in the form of a series of 'if. . . then' conditions. The inference engine searches the knowledge base to identify the rules that are relevant for a specific decision. The user interface facilitates interaction between the decision-maker and the expert system. The interface formats the key questions to the user in natural language and then interprets the responses.

Expert systems have demonstrated their ability to improve logistics productivity and quality. With the integration of logistics requirements and current information technology capabilities, it is now possible for a firm to maintain a competitive edge in today's business environment.

Expert systems, bar codes, RF technology, satellite communication capability and image processing require substantial capital investment prior to obtaining any returns. However, the primary benefit of these technologies is not lower cost but improved customer service.

3.7 ENTERPRISE RESOURCE PLANNING SYSTEMS

ERP is an information system that integrates departments and functions across a company using one database system. It runs off a single database, enabling various departments to share information and communicate with each other. It is a business management system that integrates all facets of the business, including planning, manufacturing, sales and marketing. It automates the finance and human resources departments and helps manufacturers in handling jobs such as order processing and production scheduling. ERP began as a term used to describe a sophisticated and integrated software system used for manufacturing. In their simplest sense, ERP systems create interactive environments designed to help companies manage

and analyse the business processes associated with manufacturing, such as inventory control, order taking, accounting and much more. Although this basic definition still holds true for ERP systems, their definition is expanding. In today's dynamic and turbulent business environment, there is a strong need for organizations to become globally competitive. The survival guide to competitiveness is to be closer to the customer and deliver value-added products and services in the shortest possible time. This, in turn, demands integration of the business processes of an enterprise, which is the stronghold of ERP. The economy has shifted from being based on manufacturing to service, and information has become an asset that provides the competitive advantage. ERP helps an organization in obtaining accurate and timely information. However, it is necessary for an organization to align IT spending with business strategy and needs. ERP from an IT perspective is a comprehensive software package that stores, retrieves, modifies and processes the transactions of all the functions of an enterprise in an integrated fashion. ERP is a semi-finished product with tables and parameters that user organizations and their implementation partners configure according to their business needs. An organization opts for an ERP implementation with a certain objective. The objective translates into benefits and sub-benefits. The objective of ERP implementation should be aligned with the firm's competitive strategy. ERP can bring in many benefits that can be broadly classified as strategic, operational and managerial.

An example will make the role an ERP system plays in an organization clearer. Let us say, a customer places an order and it is entered into the ERP system. The production unit will see the demand immediately and they can plan their production accordingly. They will also have access to inventory data, inventory in the pipeline, production in progress, etc. The shipment division can check the availability of goods and plan to ship the goods. Once goods are shipped and data is entered into the ERP system, the accounting unit will know the amount receivable. When a customer inquires about the possible delivery date, the customer support staff can access the inventory details, required shipping time and answer the query with reasonable accuracy. Without an ERP system, the marketing and sales unit would have to find out the answer from the production unit.

3.8 COMMUNICATION CONCEPTS

3.8.1 Signal and Data

Information exchange is an essential part of communication. It may be exchange of information among users or equipment in the communication system. In the communication context, signalling refers to the exchange of information between components required to provide and maintain data communication service. In case of PSTN, signalling between a telephone user and the telephone network may include dialling digits, providing dial tone, accessing a voice mailbox and sending a call-waiting tone etc. Looking at networking, perspectives, it is transmission of service information such as addresses, type of service etc., between nodes and/or terminals of a network. In other words, it is a process of exchanging and generating information between components of a telecommunications system

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to establish, release, or monitor connections (call handling functions) and to control related network and system operations (other functions).

Signaling System (SS7)

Signaling System 7 is the protocol designed for public switched telephone system for providing services and setting up calls. The various value-added features such as providing intelligence to PSTN services come under the service of SS7. Earlier the same physical path was used for both the call-control signaling and the actual connected call. This is called in-band signalling technique. This method of signalling was inefficient and replaced by out-of-band or common-channel signalling techniques. Out-of-band signalling performs its job by utilizing two networks in one. As we know that in PSTN, our voice and data is carried over circuit-switched network. It provides a physical path between the source and destination. The other one is the signalling network, which carries the call control traffic. It is a packet-switched network using a common channel switching protocol.

Functions of SS7

- It controls the network.
- The SS7 network sets up and tears down the call.
- It handles all the routing decisions and supports all telephony services including call forwarding, caller ID, remote network management and local number portability (LNP).

In order to accomplish the above functions, SS7 uses voice switches, which are known as Service Switching Points (SSPs). They handle the SS7 control network as well as the user circuit-switched network. Basically, the SS#7 control network tells the switching office which paths to establish over the circuit-switched network. SSPs also query Service Control Point (SCP) databases using packet switches called Signal Transfer Points (STPs). The STPs route SS#7 control packets across the signaling network. The concept of SSP, STP and SCP has been illustrated in Figure 3.18.

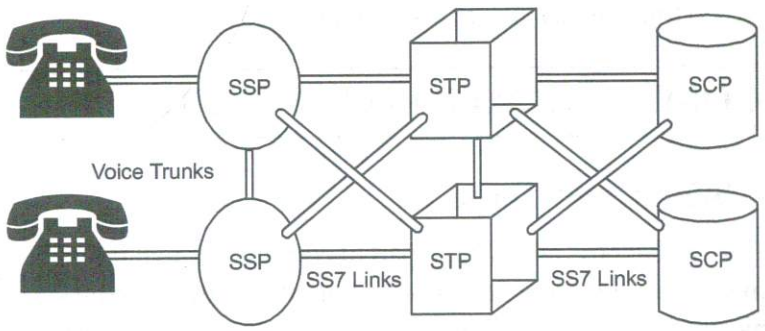

Fig. 3.18 *SS7 Signaling Points*

3.8.2 Channel

In this section we are mainly concentrating on the channel characteristics. With respect to data transmission, a channel may be defined as a path between transmitter and receiver. This path may be logical or physical in nature. It may also be hard wired or wireless. The path provides a passage for the information or data from

transmitter to receiver with certain amount of loss of information or data, which may be reproduced with other techniques. In some cases, the information may not be reproduced or the information may not reach the receiver at all. Such kinds of phenomenon may be very well-understood from the following channel characteristic issues:

Channel Noise

It is the background interference present on the channel in small amount or unwanted electrical or electromagnetic energy that carries no data or information but interferes with the information or data. Hence, noise degrades the quality of information and data by affecting communications and files of all types, including images, audio, text, programs, and telemetry. Here, information and data may be treated as signal in either electrical or electromagnetic form. If it is more than a threshold value, the data or information may not be reproduced at the receiver's end. Therefore, this may be considered as the main source for transmission errors.

The noise may be classified as external or internal noise, based upon the sources. External noise is generally picked up from electrical appliances existing in the vicinity, from the atmosphere, from electrical transformers, and also from outer space. Normally, this noise does not hamper the performance seriously. However, if there are a number of electrical appliances in use or heavy-current machines, external noise can affect communications. It also impacts communication during severe thunderstorms. A remarkably good external noise slows down the data transfer rate. The external noise is generally directly proportional to the wavelength and inversely proportional to the frequency and therefore, has a remarkable impact in wireless systems as compared to the impact in hard-wired systems. The noise generated because of electricity or atmospheric disturbances is of the order of 300 kHz, that is quite lower than the high frequency range of 300 MHz, and therefore may have more interference with the signal or information.

Noise generated in the channel or receivers is known as internal noise. Internal noise is less dependent on frequency, but has a significant effect at higher frequency, because external noise has less effect at higher frequencies. Minimizing the signal bandwidth may contain the internal noise, but this will limit the maximum speed of the data that can be delivered. Internal noise is fairly low in case of digital signal processing, fiber optics technology.

Noise is measured in terms of the signal to noise ratio S/N or SNR with decibels (dB) as unit. Hence a low ratio implies that it is not worth paying attention to the medium in question. The signal to noise ratio is calculated as follows:

$$SNR = 20\log_{10}\frac{Signal}{Noise} \quad \text{dB}$$

Channel Bandwidth

Channel bandwidth may be simply defined as the size of the range of frequencies that can be transmitted through a channel. In other words, we may define it as the volume of information per unit time that a computer, person, or transmission medium can handle. It is measured in Hertz (Hz). Bandwidth is expressed as data speed in bits per second (bps) in digital systems. In analog systems bandwidth is expressed as the difference between highest frequency and lowest frequency. Bandwidth

determines how fast data flows on a given transmission path. It is determined as the amount of data transmitted or received per unit time. It has already been explained that low bandwidth signal produces less internal noise as compared to high bandwidth signal. Therefore, this is preferred. However, in this case, we have to sacrifice data transmission speed. Therefore, a trade-off based on the performance requirements is required to be determined.

Bandwidth is affected by the physical characteristics and type of media used, data encoding method used and amount of noise present in transmission channel.

Channel Data Transmission Rate (Bit Rate)

Channel data transmission rate is determined by the maximum number of bits that can be transmitted per unit time through the physical medium. It is measured in bits per second (bps). H. Nyquist gave the maximum data rate of a noiseless channel in 1924. Further, C. Shannon extended the work of H. Nyquist and proposed a data rate for random noise.

Nyquist stated that if an arbitrary signal has been run through a low pass filter of bandwidth H, the filtered signal can be reconstructed by sampling the signal twice the frequency of the signal. Mathematically,

$$\text{Maximum data rate} = 2H \text{ Log}_2 W/\text{Second}$$

where, W represents the number of discrete levels in the signal.

The above is a case of a noiseless channel. If random (internal) noise is present the situation deteriorates rapidly. We have already explained that SNR is given by a quantity 10 log10S/N dB.

Therefore, Shannon stated that the maximum data rate of a noisy channel whose bandwidth is H Hz and whose signal to noise ratio S/N is given is represented by:

$$\text{Maximum data rate} = H \log_2(1+S/N)$$

Channel Capacity

It is the amount of information per unit time handled by either a node or a link (element, system). The messages that are transmitted may be either different or similar. The measurement is usually done in bits per second.

Transmission Time

It is the time required for transmitting a message through the channel. It is the size of the message in bits divided by the data rate in bits per second (bps) of the channel over which the transmission takes place. It is also given as the packet length divided by the channel capacity.

Propagation Time (Channel Latency)

The amount of time that is needed for the information to propagate from the source to destination through the channel. It is the distance divided by the signal propagation speed (usually the speed of light). Channel latency depends on signal propagation speed, media characteristics, and transmission distance.

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Throughput

Throughput may be defined as the number of bits, characters, or blocks passing through a data communication system over a period of time.

$$\text{Throughput} = \frac{\textit{Packet length in bits}}{\textit{Transmission time} + \textit{Propagation time}}$$

Channel Utilization

Channel utilization is nothing but the fraction of the channel's data rate actually used to transmit data. From the throughput it is observed that the propagation time and transmission time are two different parameters which are dependent upon the path length and packet length, respectively (number of bits in a message).

Hence, $$\text{Channel Utilization} = \frac{a}{1+a}$$

where, a is given as the ratio of propagation time and transmission time and is known as bit length.

We may now consider an example to understand the above concepts. Suppose, a channel's data transmission rate is 10 Mbps and the time taken by one bit to transmit through the channel is 10^{-7} seconds. The signal propagation speed in the medium is 2×10^8m/s. The transmission rate is 1bit /10^{-7} seconds that is equal to 107 bit per second (bps). Therefore, bit length will be equal to 2×10^8 m/s/10^7 bps which is equal to 20 meters.

3.8.3 Baud Rate

Bit rate is the number of bits (0 or 1) transmitted during 1 second. The number of signal changes per unit of time to represent the bits is called the data rate of the modem. That rate is usually expressed in terms of a unit known as a baud. A signal unit may have 1 or more than 1 bits. Therefore, the baud is the number of times per second the line condition can switch from '1' to '0'. Baud rate and bit rate, which are expressed in bits per second, usually are not the same, as several bits may be transmitted through the channel by the modem in each signal change (a few bits can be transmitted as one symbol). The relation between bit rate and baud is expressed as: bit rate equals the baud rate times the number of bits represented by each signal unit. Bit rate is always more or equal than baud rate. Baud rate determines the bandwidth required to transmit the signal. The signal may be in the form of pieces or block that may contain bits. A fewer bandwidth is required to move these signal units with large bits for an efficient system. To understand the relation between bit and baud rate, we consider an analogy of car, passengers and highway with signal units, bits and bandwidth respectively.

A car has capacity of carrying 5 passengers maximum at a time. Suppose a highway may support only 1000 cars per unit time without congestion. When each car on the highway carries 5 passengers, it is considered that the highway is capable of providing services without congestion. Thus highway services are treated efficient. Consider another case, when all these 5000 passengers wish to go in separate cars, they require 5000 cars and highway can only support 1000 cars at

a time. The services offered gets deteriorated because highway's capacity is meant only for 1000 cars. It does not bother as to whether these 1000 cars are carrying 1000 passengers or 5000 passengers or more. To support more cars, the highway needs to widen. Similarly, the number of bauds determines the bandwidth.

3.8.4 Bandwidth

Bandwidth may be defined as the range of frequencies assigned to a channel. In other words, we may say that bandwidth is the difference, expressed in Hertz, between the highest and the lowest frequencies of a band. In general, the higher the bandwidth, the more will be the data transmission rate or throughput. It should be noted that bandwidth and data transmission rate are very closely interrelated to each other. Any transmission system becomes more attractive if the available bandwidth is greater, introduced errors are fewer, and the maximum distance between various network elements (amplifiers, repeaters, and antennae) is greater.

Table 3.1 *Frequency Spectrum*

Name of Band	Frequency Range	Wavelength	Usage
Audible	20 Hz–20 kHz	>100 km	Voice
Extremely/Very Low Frequency (ELF/VLF) Radio	3 kHz–30 kHz	10–100 km	Radio Navigation, Weather, Submarine Communications
Low Frequency (LF) Radio	30 kHz–300 kHz	10–1 km	Radio Navigation, Maritime Communications
Medium Frequency (MF) Radio	300 kHz–3 MHz	1 km–100 m	Radio Navigation, AM Radio
High Frequency (HF)	3 MHz–30 MHz	100–10 m	Citizens Band (CB) Radio
Very High Frequency (VHF) Radio	30 MHz–300 MHz	10–1 m	Amateur (HAM) Radio, VHF TV, FM Radio
Ultra High Frequency (UHF)	300 MHz–3GHz	1 m–10 cm	Microwave, Satellite, UHF TV
Super High Frequency (SHF) Radio	3 GHz–30 GHz	10–1 cm	Microwave, Satellite
Extremely High Frequency (EHF) Radio	30 GHz–300 GHz	1 cm–.1 mm	Microwave, Satellite
Infrared Light	103–105 GHz	300–3 μ	Infrared
Visible Light	1013–1015 GHz	1–.3 μ	Fiber Optics
X-rays	1015–1018 GHz	103–107 μ	N/A
Gamma and Cosmic Rays	>1018 GHz	<017 μ	N/A

The symbols have the following meaning:

K (Kilo) = 1,000 M (Mega) = 1,000,000 (1 million)

G (Giga) = 1,000,000,000 (1 billion) T (Tera) = 1,000,000,000,000 (1 trillion)

cm = centimeter (1/100 meter) mm = millimeter (1/1,000 meter)

μ = micron (1/1,000,000 meter)

In transmission of a signal, the range of carrier frequencies depends on the nature of the medium and the requirements of the applications supported. Therefore, frequency spectrum may be defined as the range of frequencies being supported by a particular transmission medium. The actual range of frequencies supporting a given communication is known as a pass band. These are given in the Table 3.1.

Distances: Higher frequency signals offer greater bandwidth, they also generally suffer greater extent of signal attenuation than lower frequencies. This results in more errors in transmission, unless the amplifiers/repeaters are spaced more closely together. It clearly demonstrates the close and direct relationship between bandwidth, distance, and error performance. Bandwidth, in this context, refers to the raw amount of bandwidth the medium supports. Error performance refers to the number or percentage of errors, which are introduced in the process of transmission. Distance refers to the minimum and maximum spatial separation between devices over a link, in the context of a complete, end-to-end circuit.

3.8.5 Bit Rate

Bit rate is the rate over network speed which is used to detect errors while transmitting data. The most popular method for detecting errors is inserting a parity bit alongside the data bits for a character. Receiving modems detect incorrect bit rate, which is also called parity bit. It requests the sending modem to retransmit the character.

Table 3.2 *String of Data with Start and Stop Bits*

Stop Bit	Data Bits	Start Bit
0	1000001	0

Table 1.6 *String of Data with Inserted Parity Bit*

Stop Bit and Parity Bit	Data Bits	Start Bit
0	1000001	0

A modem is a bridge gap between digital and analog data transmission which allows the digital data to be transmitted/received over the telephone lines. In telecommunication and network computing, bit rate are sometimes written as data rate and are conveyed and processed per unit time. It is measured as bits per second (bit/s or bps).

Table 3.3 *The SI Prefix for Different Bits*

Bit	SI Prefix
Kilo	Kbit/s or Kbps
Mega	Mbit/s or Mbps
Giga	Gbit/s or Gbps
Tera	Tbit/s or Tbps

The net bit rate, also called useful bit rate, of a digital communication link, is the capacity of the physical layer protocol, such as: Framing Bits, Time Division Multiplex (TDM) and redundant Forward Error Checking (FEC).

The operating system indicates the connection speed of the network access technology device. The speed of connection of bit rate is determined by FEC and refers to physical layer net bit rate.

For example, the connection speed of IEEE (The Institute of Electrical and Electronic Engineers) 802.11, a wireless network, is the bit rate of 6 Mbit/s and 54 Mbit/s while the gross bit rate is between 12 Mbit/s and 72 Mbit/s which includes

error correcting codes. The connection speed of ISDN (Integrated Services Digital Network) BSI (Basic Rate Interface) that is 2 B-Channels+ 1D Channel) of 64+64+16= 144 Kbit/s refers to the user data rates, while the line rate is 160 kbit/s. The connection speed of Ethernet 100 Base–TX (TRANSMIT) physical layer is 100 Mbit/s, which is also its gross bit rate.

Throughput and digital bandwidth consumption refers to the bit rate achieved in a computer network over a logical or physical communication link via network node. Throughput is affected by traffic load of network resources, whereas data transfer rate is achieved by average net bit rate of all protocol overheads, data packet transmissions.

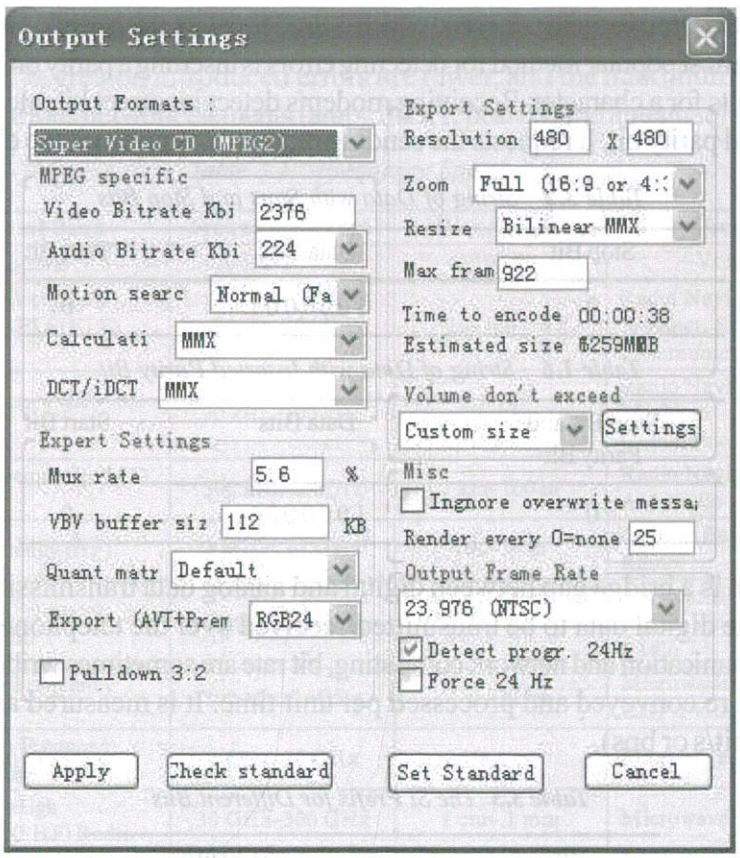

Fig. 3.19 *Output Setting of Bit Rate*

Figure 3.19 shows the video bit rate of the output MPEG file and audio bit rate, which are arranged for output setting. Motion search is set to achieve a balance between noise blurring and rendering speed around moving objects in the output file.

Multimedia Bit Rate

Bit rate is the number of bits used per unit to represent continuous medium such as audio or video following source coding (data compression) to the multimedia files. The size of the multimedia file is the product of bit rate (in bit/s) in bytes and the length of recording in seconds divided by eight. The bit rate is measured by input, which avoids interrupts with reference to streaming multimedia.

Fundamentals of Bit Rate

- The sample uses different number of bits.
- The data is encoded by different number of bits.
- The material is sampled at different frequencies.
- The information is digitally compressed by different algorithms.

Table 3.4 The Reference Standards for Different Measurements of Bit Rates

Bit Rate Measured	Reference Standard
32 Kbit/s	MW AM Quality
96 Kbit/s	FM Quality
128-160 Kbit/s	Bass Quality
192 Kbit/s	Digital Audio Broadcasting (DAB)
224-320 Kbit/s	CD Quality
800 bit/s	Recognizable Speech
8 Kbit/s	Telephone Quality
500 Kbit/s	Audio Format such as FLAC, WavPack, Monkey's Audio
1411.2 Kbit/s	Compact Disc Digital Audio Video (MPEG2)
16 Kbit/s	Video Phone Quality
128-384 Kbit/s	Business – Oriented Videoconferencing System Quality
1.25 Mbit/s	VCD Quality
5 Mbit/s	DVD Quality
15 Mbit/s	HDTV Quality
36 Mbit/s	HD DVD Quality
54 Mbit/s	Blue-Ray Disc Quality

Properties of Bit Rate with Reference to Speed

The bit rate is fixed and uniform for a specific network. The gross bit rate is the number of bits transmitted per second by an ideal transmitter. It could be as high as 1 Mbit/s. The net bit rate means the number of useful bits carried per second. The latency of bit rate is the time interval between the instant of initialization, that is, transmission request and the actual start of transmission including all algorithms and parameters. It is used to calculate the speed of time to access the network, without getting error frames.

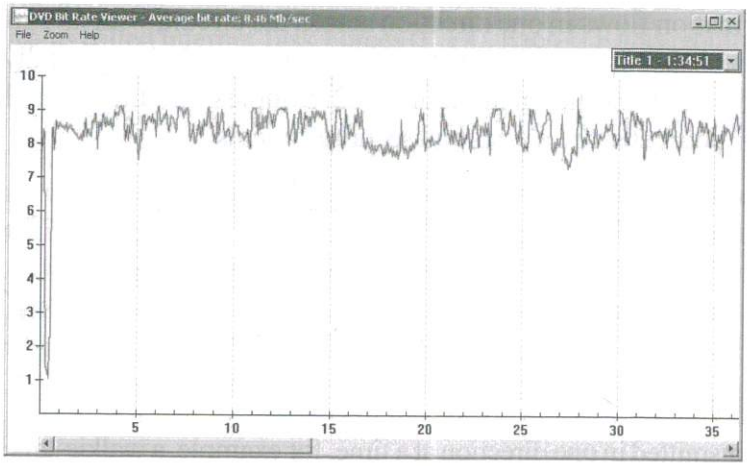

Fig. 3.20 DVD Bit Rate via Network Speed

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The above figure shows the graph of DVD bit rate viewer as average bit rate according to network searching speed.

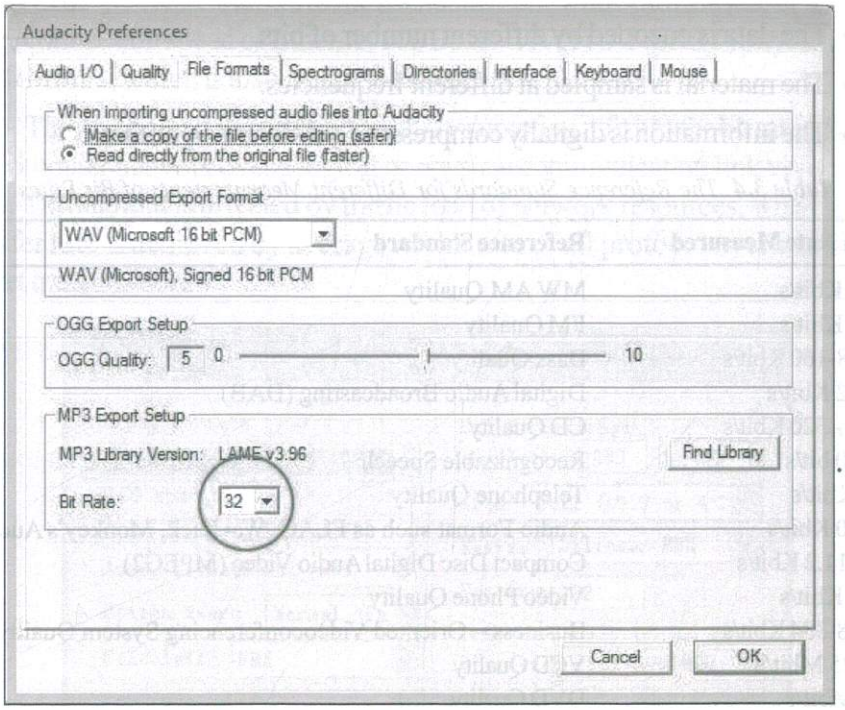

Fig. 3.21 Audacity Preferences

The above figure shows how the bit rate is set for MP3 (Music Player 3) Export set up as library version. Here, it is set as 32 Kbit/s. It is significant to export the messages as MP3s because they are smaller files as compared to WAV (Windows Media Audio) files.

3.8.6 Simplex and Duplex Communication

From the viewpoint of the direction of transmission, communication modes can be classified into the following three types:

Simplex

Data is always transmitted only in one direction. TV broadcasting is an example. The information flows in one direction across the circuit, with no capability to support a response in the other direction. Simplex transmission generally involves dedicated circuits as shown in Figure 3.22. Simplex circuits are analogous to escalators, doorbells, fire alarms and security systems.

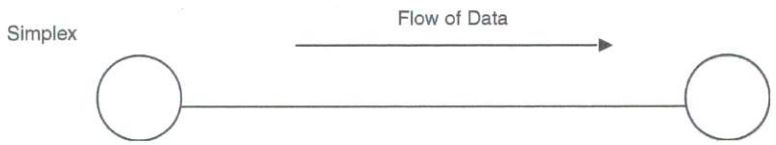

Fig. 3.22 Simplex Communication

Half Duplex

Data is transmitted in one direction at a time, for example, a walkie-talkie. This is generally used for relatively low-speed transmission, usually involving two-wire, analog circuits as shown in Figure 3.23. Due to switching of communication

direction, data transmission in this mode requires more time and processes than under full duplex mode. Examples of half duplex application include line printers, polling of buffers, and modem communications (many modems can support full duplex also).

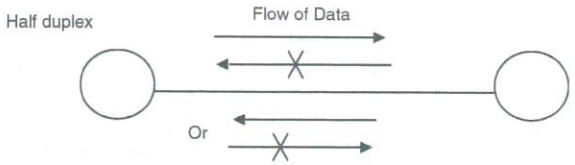

Fig. 3.23 Half Duplex

Full Duplex

Data can be transmitted in both directions at the same time. In general, four wires, as shown in Figure 3.24, are required for full duplex transmission. Full duplex typically requires two simplex circuits, one operating in each direction. All wide-band and broadband circuits are full duplex in nature, as most of the multichannel circuits. More typical examples of full duplex applications include channel links between host processors, channel links between controllers/concentrators and hosts, and other applications involving the interconnection of substantial computing systems. Services such as Frame Relay, SMDS and ATM are based on full duplex transmission.

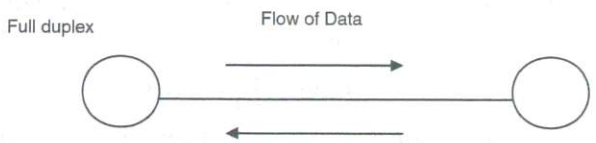

Fig. 3.24 Full Duplex

3.9 PROTOCOLS AND STANDARDS

The group of people responsible for monitoring and reviewing the progress made in developing TCP/IP, initiated by US Department of Defense, is known as the Internet Activities Board (IAB). Gradually, the IAB evolved from a DARPA-specific research group into an autonomous organization. Its members chaired smaller groups called Internet Task Forces (ITFs). Each ITF was required to deal with different aspects of the evolution of TCP/IP and the Internet. In 1989, the IAB was reorganized. Two subsidiary groups were created viz., the Internet Engineering Task Force (IETF) and the Internet Research Task Force (IRTF). The former was assigned the task of developing the Internet standards, and the latter was made responsible for research and development. The Internet Society (ISOC) was formed in 1992 as the standardizing body for the Internet Community. The IAB was renamed as the Internet Architecture Board (IAB). For issuing new standards this group relies on the Internet Engineering Task Force (IETF), and for coordinating values shared among multiple protocols it relies on the Internet Assigned Numbers Authority (IANA).

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3.10 TRANSMISSION IMPAIRMENTS

In data communication the signal has to travel through the transmission media that may be wired or wireless. The transmission media may not be perfect and causes a number of impairments in the signal and sometimes, they are so damaging that the original signal could not be obtained at the receiving end or it could be deciphered partly. The signal, which is received, will differ from the signal that is transmitted due to transmission impairments. These impairments cause various modifications that degrade the signal quality. A binary 1 may be changed into a binary 0 and vice versa due to bit error. There exist three causes of impairment. They are attenuation, distortion and noise.

Attenuation

When signal amplitude degrades along a transmission medium, this is called signal attenuation. When a signal passes over the transmission media and electronic circuitry to finally reach its destination, the signal loses its power or energy. Attenuation is the loss of the signal power of signal while traversing a transmission media including electronic circuitry and is measured in terms of decibel (dB). Distortion is calculated as the ratio of the signal at two different points or relative power of two signals at the same point. A negative value of decibel indicates loss of signal strength and a positive value of decibel indicates gain in signal strength. The relative strength of the signal is given by:

$$10 \log_{10} (P_2/P_1) \text{ dB}$$

When an electromagnetic signal travels through a media, it progressively loses energy as a result of absorption of energy. The reduction in amplitude of a signal increases as it travels farther from the point of origin. In some instances, the signal degrades so much that it becomes difficult to obtain the original signal. Likewise, the electronic circuitry also tends to take away some of the signal power in the form of heating of the copper, metals, etc. These are not the only causes, there exists more causes that degrade the signal energy. All these causes have therefore necessitated amplifying the signal at some intermediate points along the path while it travels through electronic circuitry and transmission media. Amplifiers or repeaters are inserted at intervals along the medium to improve the received signal as close as possible to its original level. The attenuation includes a number of factors like transmitting and receiving antennas, transmitter powers, modulation techniques, frequency of the transmission, atmospheric conditions, etc. Distortion is proportional to the square of the operating frequency.

Distortion

Distortion is the change in shape or form of a signal, when a signal travels through a electronics circuitry and transmission media. A signal produces harmonic frequencies as and when it passes through non-linear electronic circuitry and becomes composite signal. Likewise a signal experiences varied frequency while passing through a guided medium. The signal will include some harmonic distortion or unwanted frequencies. Thus the signal composed of different frequencies will

have different propagation speed and therefore experience different propagation delay to arrive at the destination. This causes a signal to distort and change its original shape while passing over a transmission media. All these factors causes signal components of one bit position to spill over into other bit position and lead to change in waveform and information. As the distortion causes delay in the signal and increase in the bit rate, some of the frequency components associated with each bit transition are delayed and start to interfere with frequency components associated with a later bit. This phenomenon is called intersymbol interference, which is considered as one of the major limitations to maximum bit rate. Equalizing devices are inserted at intermediate points to keep the shape of the signal intact.

Channel Noise

It is a small amount of background interference in the channel or unwanted electrical or electromagnetic energy. This unwanted electromagnetic energy is referred to as noise. This does not carry data or information but interferes with the signal. The information and data is nothing but signal in electromagnetic form. Hence, noise degrades the quality of information and data. When noise has a value more than a threshold value, the receiver will not be able to distinguish between signal and noise and therefore data or information may not be reproduced at the receiver's end. This is considered as one of the main sources for transmission errors.

The noise may be classified as external or internal noise based upon the sources. External noise is generally picked up from electrical appliances present in the vicinity, atmosphere and even outer space. Normally, this noise does not hamper the performance very seriously. However, if there are a number of electrical appliances in use external noise can affect communications as an outcome of cascading. The external noise is generally inversely proportional to the frequency and directly proportional to the wavelength. The external noise has a remarkable impact in wireless systems than in wired systems.

Noise generated inside channel or receivers is known as internal noise. Internal noise is less dependent on frequency but has a significant affect at higher frequency because external noise has less impact at these frequencies. Minimizing the signal bandwidth can control the internal noise but this will limit the maximum speed of the data that can be delivered. Internal noise is fairly low in case of digital signal processing, fiber optics technology. Noise is measured in terms of the signal to noise ratio S/N or SNR with decibels (dB) as unit. Hence a low ratio implies that it is not worth paying attention to the medium in question. The signal to noise ratio is calculated as follows:

$$\text{SNR} = 20 \log_{10} \times \frac{\text{Signal}}{\text{Noise}} \text{ dB}$$

Data Rate Limits

A channel puts limit on the rate of transmission of data rate. Data transmission rate is dependent on the bandwidth of the channel and the level of the signal which is being transmitted. There exists another important factor for determining the quality of the channel. That is the presence of level of noise in the channel.

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3.11 NETWORKS

In the mainframe and minicomputer environment, each user is connected to the main system through a dumb terminal that is unable to perform any of its own processing tasks. Processing and memory are centralized in this environment. However, although this type of computerization has its merits, the major disadvantage is that the system can easily get overloaded as the number of users, and consequently, terminals increase. Second, most of the information is centralized to one group of people, the systems professionals, rather than the end-users. This type of centralized processing system differs from the distributed processing system used by LANs. In a distributed processing system, most of the processing is done in the memory of the individual PCs or workstations. Besides, they share expensive computer resources like software, disk files, printers and plotters, etc.

One may question why PCs are not, be connected together in a point-to-point manner. The point-to-point scheme provides separate communication channels for each pair of computers. When more than two computers need to communicate with one another, the number of connections grows quickly as the number of computers increases. Figure 3.25 illustrates that two computers need only one connection, three computers need three connections and four computers need six connections.

Figure 3.25 illustrates that the total number of connections grows more rapidly than the total number of computers. Mathematically, the number of connections needed for N computers is proportional to square is:

Point-to-point connections required = $(N^2–N)/2$

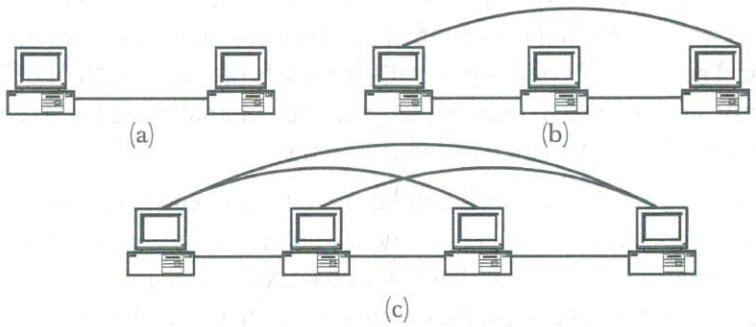

Fig. 3.25 *(a), (b), (c) Number of Connections for 2, 3, 4 Computers, Respectively*

Adding the Nth computer requires N–1 new connections, which becomes a very expensive option. Moreover, many connections may follow the same physical path. Figure 3.26 shows a point-to-point connection for five computers located at two different locations, say, the ground and the first floor of a building.

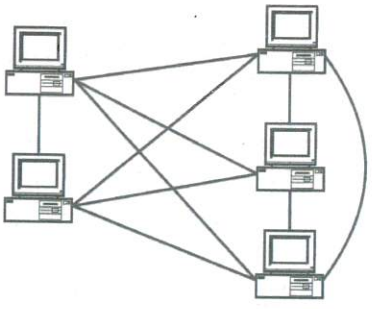

Fig. 3.26 Five PCs at Two Different Locations

Components of a Network

In general, a computer network is composed of one or more servers, workstations, network interface cards, active and passive hubbs, routers, bridges, gateways, modem, software components like network operating systems and other application software. The following components are widely used for the construction of networks:

Server

It is the most powerful computer of the network. Usually in a local area network, a powerful microcomputer or a super microcomputer with the power of a minicomputer is used as a server. Two types of servers are normally employed in a local area network: *dedicated* servers and *non-dedicated* servers.

In a dedicated server, the server computer performs functions and services for the entire network. It helps to efficiently run user applications and increases the overall system cost. Users cannot run their applications directly in a dedicated server. It provides e-mail service and faster response time. It also enables computers to share multiple hard disks and other such resources. Dedicated servers are usually employed for larger networks with a heavy load.

In a non-dedicated server, apart from the role of a network controller, a server too acts as an individual workstation. The server is equipped with a large memory. Network operations demand only a portion of server memory. The remaining portion of the memory may be used for user applications. Under light load conditions, it is advisable to use a non-dedicated server. Some servers can operate on both modes according to the requirement of the user.

File Server

The primary goal of a computer network is to share data among several users. They also make their attached disk drives, printers, modems and unique communication links available to the various client stations. Providing one computer with one or more hard disks facilitates this. All client stations share these hard disks. Clients can make their requests to access any of the shared facility to the server. The file server is a powerful computer, which runs a special software. It provides files and other shared resources to different users in the network. It provides facilities like user authentication and security to various user programs and data. It can be accessed through the Network Operating System (NOS).

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Typical configurations of a server are Pentium 4 machine with 128 MB or a higher capacity RAM, 40 GB or a higher capacity hard disk, to serve upto 10 nodes or workstations.

All activities of a file server can be monitored and controlled from a monitor called console. The network administrators are given special privileges. They are given supervisory passwords. They perform network administration operation for the entire network. If any user of the network needs to get a new network service, they have to contact the network administrator and make a request for the specific service they require. The file server has a large memory, which is used for caching directories, and files and hashing directories. Novell Netware and Windows NT are the two network operating systems that run on a server machine.

Workstation

Another important component of a network is the workstation or the client. A workstation is an individual computer with capabilities to communicate with other machines. It must be equipped with the necessary hardware and software to connect to a LAN. Usually a Network Interface Card (NIC) or an Ethernet card or an Arcnet card is used for this purpose. Part of the network operating system is also available in the workstation. A workstation can communicate with other workstations or to a server. The hardware requirement for a workstation depends on the application and the size of the network. In a typical LAN of a university computer center, a Pentium III system with 64 MB RAM and 4 to 8 GB hard disk capacity, with necessary network interface card can be used for a typical workstation. In general, the memory and hard disk capacity of a workstation is much less than that of a server.

Network Interface Unit

Every computer on the network needs one add-on card called Network Interface Card (NIC) or Ethernet Adapter or Network Interface Adapter. The role of NIC is to move the serial signals on the network cables, or media into a parallel data stream inside the PC. In some cases, two or more such NICs are used in the server to split the load. These interface units also have the important job of controlling access to the media. This includes activities known as carrier sense (listen before transmit), sequential station number and token passing.

Transmission Media

Data signal travels through this medium. It has two general categories: bounded (guided) and unbounded (unguided). Twisted pair, coaxial and fibre optic cables are all bounded media. The data signals travel within the boundaries of the transmission media. On the other hand, microwave and satellite transmissions, travel through air, which has no boundaries, and hence are called unbounded transmission.

Hub

Network hub is a centralized distribution point for all data transmission in a network. A hub may also be referred to as a concentrator. Data packet from an NIC arrives at the hub. The hub receives and rebroadcasts them to other computers connected to it. In general, the hub network is a passive device. It does not know the

destination of a received data packet. Hence, it is required to send copies to all the hub connections. Hubs can be classified into the following three categories:

- Stackable and non-stackable hubs.
- Active and passive hubs.
- Intelligent and non-intelligent hubs.

Stackable hubs are hubs that can be stacked or interconnected to make a single hub appearance. They are useful for vendors to make hubs of sizes suitable to customer requirements. Non-stackable hubs cannot be interconnected. They always provide only a fixed number of connections.

Hubs that connect to the network backbone are known as active hubs. Those hubs which connect only to active hubs, are known as passive hubs.

Intelligent hubs contain a special firmware that can be accessed by remote workstations. The firmware is known as Simple Network Management Protocol (SNMP). Network performance and network status data are read from SNMP.

Repeater

A repeater is a communication device that connects two segments of the network cable. It retimes, regenerates and strengthens the digital data and sends them on their way again. Repeaters are often used to extend the cable length to enlarge LANs. Wide area network contains many repeaters. Ethernet also frequently uses repeaters to extend the length of the bus.

Bridge

A bridge interconnects two networks using the same technology, (such as Ethernet or Arcnet). A bridge is more sophisticated than a repeater. A modern bridge reads the destination address of the received packet and determines whether the address is on the same segment of the network cables of the originating station. If the destination is on the other side of the bridge, the bridge transmits the packet into the traffic on that cable segment. Local bridges are used to connect two segments of the same LAN. Remote bridges are used to link local LAN cables to thin long distance cables and thus links two physically separated networks. Network administrators often use bridges to split big networks into a number of small networks. Bridges are easy to install. They provide an easy way to perform network management functions.

Router

A router transfers data between networks. It is also possible for a router to transfer data between different compatible network technologies such as Ethernet and IBM token ring. Since the Internet consists of thousands of different network technologies, routers are an integral part of the Internet. A router has its address on the network. A bridge does not have an address. Hence, a router can act as an intermediate destination. In other words, a computer can send a data packet to the router of another network. A router will transfer the packet to the other networks. On the other hand, a bridge must examine all the packets to determine which packets to transmit between networks. As such, computers never send packets directly to a bridge. A router examines a packet only if it contains the router's address.

A router can also act as a bridge. Such a router is known as a *brouter*. The brouter receives a packet and examines whether it supports the protocol used by the packet. If not, it simply drops the packet. A packet is bridged using the physical address information.

Gateway

Two dissimilar networks can be connected by means of a gateway. For example, a mainframe can be connected and made accessible to a PC network by means of a gateway. Unlike routers, a gateway converts the format of the data sent between two networks. A router adds only addressing information to the data packet. Routers never change the content of the message. But a gateway has to identify the protocols used in the networks, and recognize the data format and convert the message format into a suitable format which is acceptable by the other networks. Wide area networks often use gateways because there is a large number of dissimilar networks present in a WAN. Gateways provide good connectivity to different kinds of networks on the Internet.

Modem

Another significant network component is a modem. The term modem is the shortened version of the name modulator–demodulator. A modem provide two-way communication facility between a computer network and a telephone network. As a Wide Area Network employs the existing telephone network to connect to a distant network, it always uses a modem to dial-up the telephone network. A modem converts the digital data from the computer into useful analog signals that can be transmitted through a telephone network. Similarly, signals from the telephone channels are converted back into digital data suitable for a computer.

Check Your Progress

6. Define the term expert system.
7. What is channel noise and how does it affect transmission?
8. What determines the channel data transmission rate?
9. What do you understand by the term 'attenuation'?
10. What is a server?
11. What is a workstation?

3.12 TYPES OF NETWORKS

This section will discuss the various networks, that is, LAN, WAN and MAN

Local Area Network

Networks that are privately owned, offer consistent fast-paced communication channels which are optimized to connect information processing tools in a restricted geographical area. These are known as Local Area Networks (LANs).

A shared, local (restricted-distance) packet network for computer communication is a form of LAN. A common medium is used by LAN to link

peripherals and computers so that the user can share access to databases, files, host computers, peripherals and applications.

LANs, in addition to linking the computer equipment available on a particular premise, also provide a connection to other networks either through a computer, which is attached to both networks, or through a dedicated device called a gateway. The main users of LANs include business organizations, research and development groups in science and engineering, and industry and educational institutions. The electronic or paperless office concept is possible with LANs.

The Local Area Network (LAN) technology connects people and machines within a site. A local area network is a network that is confined to a relatively small area as shown in Figure 3.27. LANs are described as privately owned networks that offer reliable high-speed communication channels optimized for connecting information processing equipment in a limited geographical area, namely, an office, building, complex of buildings, and school or campus.

A LAN is a form of local (limited-distance), shared packet network for computer communication. LANs interconnect computers and peripherals over a common medium, so that, users might share access to host computers, databases, files, applicationsand peripherals. They can also provide a connection to other networks either through a computer attached to both networks, or through a dedicated device called a gateway.

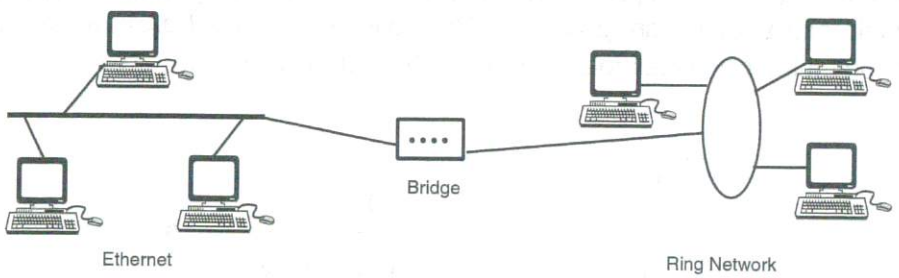


Fig. 3.27 Local Area Network (LAN)

The components used by LANs can be divided into cabling standards, hardware, and protocols. Various LAN protocols are Ethernet, Token Ring, TCP/IP, SMB, NetBIOS and NetBeui, IPX/SPX, Fibre Distributed Data Interchange (FDDI) and Asynchronous Transfer Mode (ATM).

LAN in an Organization

A Local Area Network or LAN, connects computers that are in the same building but a few kilometres apart. A LAN usually uses bus or ring topology. Fibre Distributed Data Interface (FDDI) is also becoming popular. The transmission rate varies from 10 million bits per second to 1 gigabits per second (10Mbps-1Gbps). A LAN is usually under the control of a single organization. Almost 70 per cent of all LANs in the world use the Ethernet, which is a bus topology. Here, all the computers are connected to one circuit. IEEE 802.3 is the standard for the Ethernet.

A typical LAN in an organization consists of a file server, a database server, an application software server and a Web server. There may be about 100 desktop systems and a single printer server. Earlier, computers were connected using hubs,

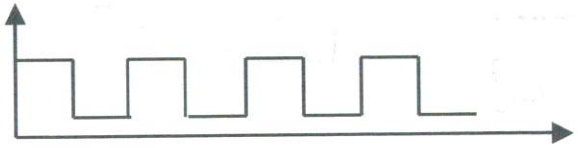
which have now been replaced by switches. All computers are connected to a switch.

The prime objective of a LAN is to facilitate information and resource sharing within an organization. Application software, for example, which is used by many people in an organization can be installed on one computer. This computer can be made accessible to other computers through a LAN and everybody can use the same software. The machine on which the software is installed is often called a server. In the absence of a LAN, the same software has to be installed on all the machines, which may be very expensive. In addition, an upgrade in the software requires re-installation/modification on all the computers. The server may be a file server, a printer server or a database server, depending on the service it provides to its users.

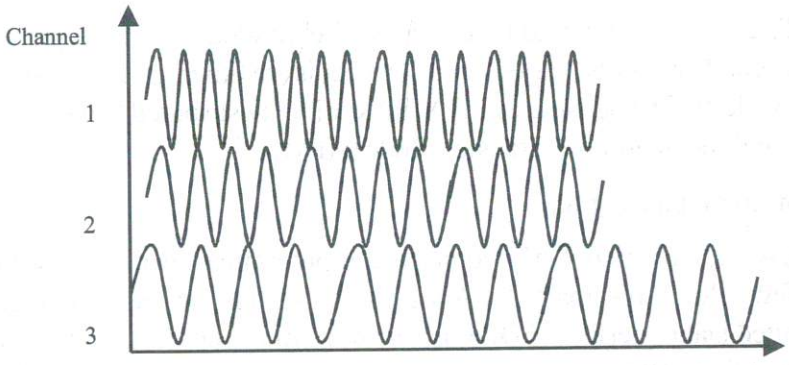
Several LANs of an organization are connected with each other through a backbone network. A backbone network is usually much faster than the LANs it connects. Each LAN may be connected to the backbone network through a switch gateway. There are numerous other ways of connecting LANs together. Usually, the administration of each LAN is done by the department system administrator and the backbone is managed by the computer centre systems administrator.

Broadband versus Baseband LAN

There exist two LAN transmission options—baseband and broadband. Baseband LAN, which is the most prevalent by far, is a single-channel system that supports a single transmission at any given time. Broadband LANs, which are most unusual, support multiple transmissions via multiple frequency channels.



Baseband may use UTP, Coaxial or Fibre



Broadband using coaxial cable

Fig. 3.28 Broadband versus Baseband

Broadband LANs

Broadband LANs are multichannel, analog LANs as shown in Figure 3.28. They are typically based on coaxial cable as the transmission medium, although fibre optic cable is also used. Individual channels offer bandwidth of 1 to 5 Mbps, with

20 to 30 channels typically supported. Aggregate bandwidth is as much as 500 MHz. Its characteristics are:

- Stations connected via RF modems, i.e., radio modems accomplish the digital-to-analog conversion process, providing the transmitting device access to an analog channel.
- Digital signal modulated onto RF carrier (analog).
- Channel allocation based on FDM.
- Head-End for bidirectional transmission.

Advantages

- Has greater bandwidth.
- Data, voice and video can be accommodated on broadband channel.
- Covers greater distances.

Disadvantages

- Incurs high cost, requires modems.
- Lacks well-developed standards.
- Can be supported only by a coaxial cable.
- Requires alignment and maintenance.

Some broadband LANs are referred to as 10Broadband36 where 10 stands for 10 Mbps, broadband for multichannel and 36 for 3600 metres maximum separation between devices.

Baseband LANs

A baseband LAN is a single channel, supporting a single communication at a time as shown in Figure 3.28. It is digital in nature. It provides a total bandwidth of 1 to 100 Mbps over a coaxial cable, UTP, STP, or fibre optic cable. Distance limitations depend on the medium employed and the specifics of the LAN protocol. Baseband LAN physical topologies include ring, bus, tree and star topologies.

Baseband LANs are by far the most popular and the most highly standardized. Ethernet, Token Passing, Token Ring and FDDI LANs are all baseband. They are intended only for data, as data communication is, after all, the primary reason for the existence of LANs. The characteristics of this system may be summarized as follows:

- No need of modems – low cost installation.
- Bidirectional propagation of signal.
- Unmodulated digital signal.
- Single channel.
- Stations connected via T connectors.

Advantages

- Simplicity.
- Low cost.
- Ease of installation and maintenance.
- High rates.

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Disadvantages

- Limited distances.
- Data and voice only.

Advantages of LAN

LANs are used almost exclusively for data communication over relatively short distances such as within an office, office building or a campus environment. LANs allow multiple workstations to share access with multiple host computers, other workstations, printers and other peripherals, and connections to other networks. LANs are also being utilized for imaging applications. They are being used for video and voice communication as well, although currently on a very limited basis.

LAN applications include communication between the workstation and host computers, other workstations and servers. The servers may allow the sharing of resources. Resources could be information, data files, e-mail, voice mail, software, hardware (hard disk, printer, fax, etc.) and other networks.

LAN benefits include the fact that a high-speed transmission system can be shared among multiple devices in support of large number of active terminals and a large number of active applications in the form of a multi-user, multi-tasking computer network. LAN-connected workstations realize the benefit of decentralized access to very substantial centralized processors, perhaps in the form of mainframe host computer and storage capabilities (information repositories). Additionally, the current technology allows multiple LANs to be inter-networked through the use of LAN switches, routers, etc.

Disadvantages of LANs include concern for security of files and accounts.

Metropolitan Area Network (MAN)

A Metropolitan Area Network (MAN) covers large geographic areas such as cities or districts. By interconnecting smaller networks within a large geographic area, information is easily disseminated throughout the network. Local libraries and government agencies often use a MAN to connect with citizens and private industries. It may also connect MANs together within a larger area than a LAN. The geographical limit of a MAN may span a city. Figure 3.29 depicts how a MAN may be available within a city.

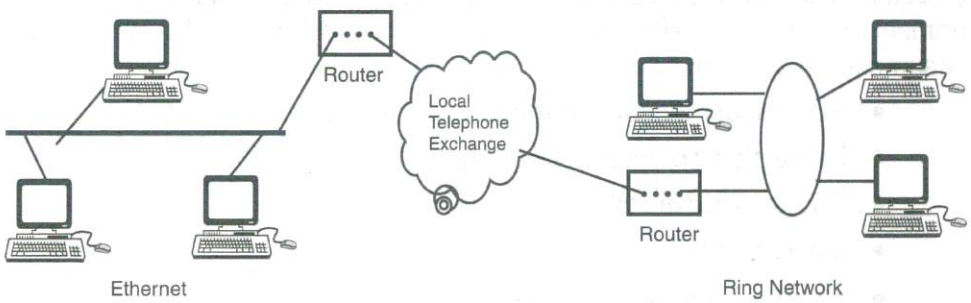

Fig. 3.29 *Metropolitan Area Network (MAN)*

In MAN, different LANs are connected through a local telephone exchange. Some of the widely used protocols for MAN are RS-232, X.25, Frame Relay, Asynchronous Transfer Mode, ISDN, OC-3 lines (155 Mbps), Asymmetrical Digital Subscriber Line (ADSL), etc. These protocols are quite different from those used for LANs.

Wide Area Network

A Wide Area Network (WAN) connects networks in different cities or countries. Gateways are used to connect these networks. A network which can connect networks that are over a hundred kilometres apart is not built by any organization. Instead, the organization uses leased telephone lines, satellite links or other wireless media to provide this service. It is obvious that a WAN is not owned by a single organization. It is owned and managed collectively by many cooperating organizations.

This technology connects sites that are in diverse locations. Wide Area Networks connect larger geographic areas, such as New Delhi, India or the world. The geographical limit of WAN is unlimited. Dedicated transoceanic cabling or satellite uplinks may be used to connect this type of network. Hence, a WAN may be defined as a data communication network that covers a relatively broad geographic area to connect LANs together between different cities with the help of transmission facilities provided by common carriers, such as telephone companies. WAN technologies function at the lower three layers of the OSI reference model. These are the physical layer, the data link layer and the network layer.

Figure 3.30 explains a WAN, which connects many LANs together. It also uses switching technology provided by local exchange and long distance carrier.

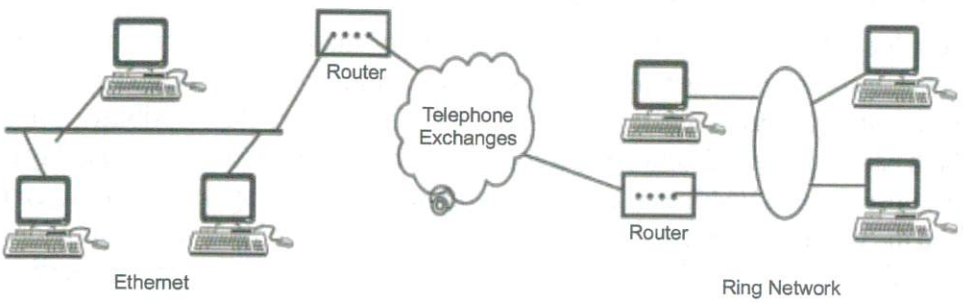

Fig. 3.30 *Wide Area Network (WAN)*

Packet switching technologies, such as Asynchronous Transfer Mode , Frame Relay, Switched Multimegabit Data Service (SMDS) and X.25 are used to implement WAN along with statistical multiplexing to enable devices to share these circuits.

The difference between MAN and WAN may be understood only from the services being used by them. WAN uses both local and long distance carrier while MAN uses only local carrier. Hardware and protocols are same for both.

Private Branch Exchanges

Networks may be classified on the basis of their geographic scope into local networks and wide area networks. Wide area networks encompass a relatively wider geographic area, from several miles to thousands of miles, whereas local networks link local resources, such as computers and terminals in the same department or building of a firm. Local networks consist of private brand exchanges and local area networks.

A *Private Branch Exchange* (PBX) is a special-purpose computer designed for handling and switching office telephone calls at a company site. It can

belong to a company or to a provider. Today's PBXs can carry voice and data to create local networks. PBXs can store, transfer, hold and redial telephone calls and also switch digital information among computers and office devices. Using a PBX, you can write a letter on a PC in your office, send it to the printer, then dial up the local copying machine and have multiple copies of your letter created.

The advantage of digital PBXs over other local networking options is that they do not require special wiring. A PC connected to a network by telephone can be plugged or unplugged anywhere in a building using the existing telephone lines. Many commercial vendors provide/maintain PBX services, so an organization does not require a special expertise to manage them.

The geographic scope of PBXs is limited, usually to several hundred feet, although a PBX can be connected to other PBX networks or to packet-switched networks to encompass a larger geographic area. The primary disadvantages of PBXs are that they are limited to telephone lines and cannot easily handle very large volumes of data.

Network Services and Broadband Technologies

In addition to topology and geographic scope, networks can be classified on the basis of the service they provide.

Value-Added Network (VAN)

A value-added network is a private, third-party-managed network that offers data transmission and network services to subscribing firms. Let us say, a business firm wants to communicate purchase orders to its vendor. One possibility is that both parties join hands and set up a communication system. Another possibility is to subscribe to a VAN service provider who will set up the system and the buyer and the vendor will be connected to each other through the VAN service provider. The VAN service provider will facilitate communications between both parties. The parties pay only for the amount of data they transmit along with a subscription fee. VANs are cost effective because of economies of scale.

Other Network Services

It is more expensive to talk on a phone than to chat on the Internet. The latter is cheaper because the packet switching protocol it uses enhances the use of communication channels. In the case of telephone lines, circuit switching is used wherein the circuits are switched to establish an end-to-end communication channel which is dedicated to the duration of the conversation. In packet switching, each message (voice, data, graphic) is broken down into multiple packets and each packet has information about the destination and the sequence. Each packet then travels on its own , from source to destination, using the available communication channels. The packets are assembled together into a message at the destination.

Integrated Services Digital Network (ISDN)

It is an international standard to access dial-up network that integrates voice, data, image and video services in a single link. Organizations and individuals that require the ability to provide simultaneous voice or data transmission over one physical line might choose this service. Primary Rate ISDN offers transmission capacities in the megabit range and is designed for large users of telecommunication services.

Like ISDN, digital subscriber line (DSL) technologies also operate over existing copper telephone lines to carry voice, data and video, but they have higher transmission capacities than ISDN.

High-speed transmission technologies are sometimes referred to as broadband. The term broadband is also used to designate transmission media that can carry multiple channels simultaneously over a single communications medium. Broadband media is available in most big cities in India.

Network Convergence

As mentioned earlier, the need today is to have a single set-up to transmit voice, data and video in a single network infrastructure. These multi-service networks can potentially reduce networking costs by eliminating the need to provide support services and personnel for each type of network. Many devices are available nowadays that use ISDN to provide such facilities.

3.13 COMMUNICATION NETWORKS

LANs are classified depending on the topology, access methods, signalling methods, transmission medium and transmission mode.

Topologies and Design Goals

The control of the network is of two types viz., centralized and distributed. With centralized control, access to the network and allocation of channel is controlled by one node, such as a dedicated communications processor or switch. When control is distributed, nodes have the ability to establish connections and access the network channel independently, according to an accepted set of rules.

Most LANs are based on simple structured topologies, like the ring, bus or star. Some of the basic characteristics of these topologies are outlined as follows:

Hierarchical Topology

A hierarchical topology connects multiple star networks to other star networks. This type of topology contains a central root node that is a top-level hierarchy which is connected to one level lower in the hierarchy. It maintains a point-to-point link at the end of the previous level node. The total number of point-to-point links in a network is based on the physical hierarchical topology.

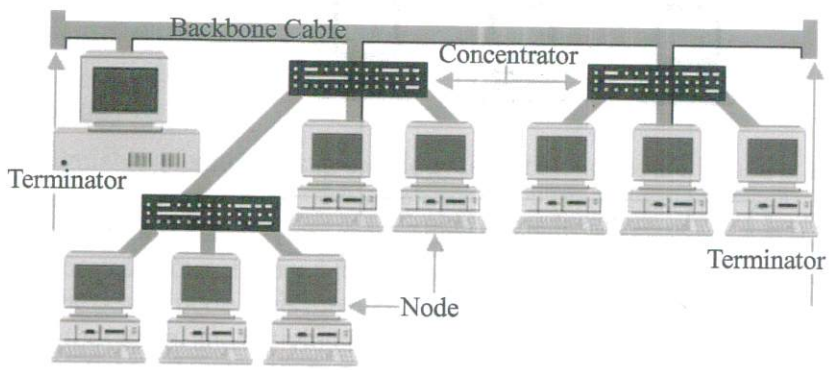

Fig. 3.31 Nodes Setting in Hierarchical Topology

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Features

- This topology will have at least three hierarchies in the hierarchy network, all based on the root mode.
- It supports two networks, the star and the linear topology, which connect the node.
- Nodes can be added at any level of hierarchy.
- The higher level in the hierarchy performs more functions than the lower level.

Advantages

- It supports point-to-point connections and wiring for individual segments.
- Systems access immediate and larger networks.
- It is supported by several hardware and software vendors.

Disadvantages

- The whole network depends on the type of cable.
- It depends on the root trunk which is the backbone of the network.
- If a root network fails, the entire network will fail.
- It is difficult to configure.

Horizontal Topology (Bus)

Bus topologies are multipoint electrical circuits that can be implemented using coaxial cable, UTP or STP. In a bus topology, data transmission is bidirectional, with the attached devices transmitting in both directions. While generally operating at a raw data rate of 10 Mbps, actual throughput is much less.

It is employed frequently in the LANs with distributed control in all nodes, as shown in Figure 3.32, share the common bus. Messages placed on the bus are transmitted to all nodes. Nodes must be able to recognize their own address in order to receive messages. However, unlike nodes in a ring, they do not have to repeat and forward messages intended for other nodes. As a result, there is none of the delay and overhead which is ordinarily associated with retransmitting messages at each intervening node. Because of the passive role that a node plays in transmission on the bus, network operation will continue in the event of node failures. This makes distributed BUS networks inherently resistive to single-point failures.

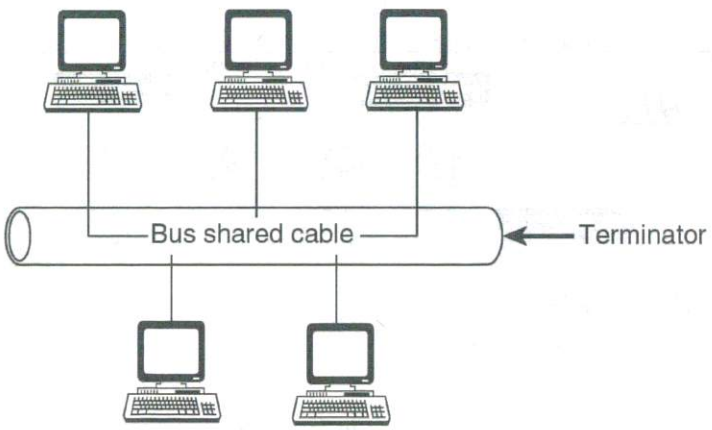

Fig. 3.32 Bus Topology

Bus networks employ a decentralized method of media access control known as CSMA (Carrier Sense Multiple Access), that allows the attached devices to make independent decisions relative to media access and initiation of transmission. This approach results in data collisions and requires frequent retransmission. Bus networks are specified in the IEEE 802.3 standard, and generally have a maximum specified length of 1.5 miles (2.5 km). Ethernet is based on a bus topology. A tree topology is a variation of the bus topology, with multiple branches off the trunk of the central bus. Bus networks also suffer from the vulnerability of the bus, that is, if one node is down, all nodes in the bus will be down. Similarly, tree networks depend on the integrity of the root bus.

Ethernet

Ethernet is the best alternative to a high-speed and cost-effective LAN. Data is transmitted and received at the rate of 10 million bits per second. Heavy coaxial cable (thick net) or fibre optic cable are used to transfer data between wiring closets. Thick net coaxial is made to use over medium-long distances where the level of reliability required is medium. A light duty coaxial cable known as thin net is normally used to connect workstations within the same room. Figure 3.33 shows the scheme of Ethernet where a sender transmits a modulated carrier wave that propagates from the sender toward both ends of the cable.

Ethernet was first designed and installed by Xerox Corporation at its Palo Atto Research Center (PARC) in the mid-1970. In the year 1980, DEC Intel and Xerox came out with a joint specification which has become the de facto standard. Ethernet was named DIX from this period onwards. It gained this name after its business sponsors Digital, Intel, and Xerox.

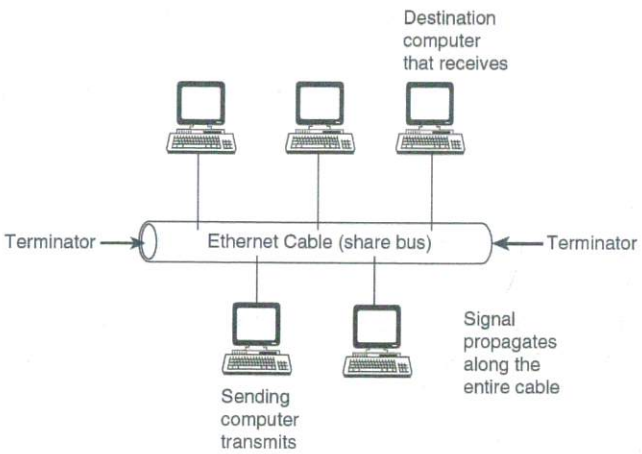

Fig. 3.34 Signal Flow across an Ethernet

Star Topology

The distinguishing feature of star topology is that all nodes are joined at a single point, as shown in Figure 3.34. This single point is called as a central node, hub, or switch, to which all other devices are attached directly, generally via UTP or STP. This topology is frequently used for networks in which control of the network is located in the central node. This method is optimal when the bulk of communication is between the central and outlying nodes. If traffic is high between outlying nodes, an undue switching burden is placed on the central node.

Transmission rates vary with AT&T's Star LAN operating at 1 to 10 Mbps, and both 100 Base-T and 100VG-AnyLAN at 100 Mbps. The primary advantage of a star is that a disruptive or failed station can be isolated, thereby eliminating any negative effect it may have on LAN performance. Additionally, each node has access to the full bandwidth of the LAN, at least in a LAN switch environment. The primary disadvantage is that a hub failure is catastrophic. Since the entire connectivity is provided through the central hub, its failure affects the entire LAN.

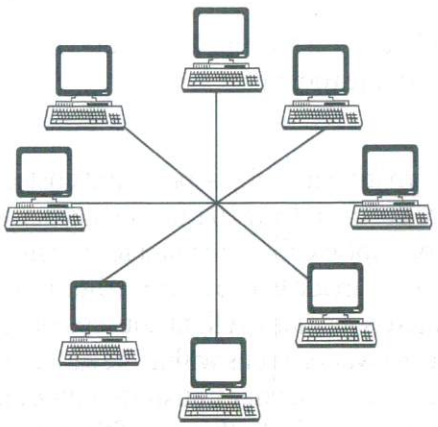

Fig. 3.34 Star Topology

Asynchronous Transmission Mode (ATM)

Asynchronous Transfer Mode (ATM) is an International Telecommunication Union-Telecommunication Standardization Sector (ITU-T) and is a standard for cell relay. Here, information about video, data or voice and other service types is communicated in tiny, fixed-size cells. Networks of ATM's are connection-oriented. ATM has emerged as a standard in communication. It provides medium to high bandwidth and a virtual link between the delivery of real-time data, video and voice.

Ring Topology

The ring architecture is a distributed architecture, with minimal connectivity and a topology of two links connected to every node as shown in Figure 3.35 and forms unbroken circular configuration. Figure 3.35 shows a network laid out in a physical ring, or closed loop, configuration. Transmitted messages travel from one node to another around the ring. Each node must be able to recognize its own address in order to accept messages.

Information travels around the ring in only one direction, with each attached station or node serving as a repeater. Rings generally are coaxial cable or fibre in nature, operating at raw transmission rates of 4, 16, 20 or 100 Mbps or more. Rings are deterministic in nature, and employ token passing as the method of media access control to ensure the ability of all nodes to access the network within a predetermined time interval.

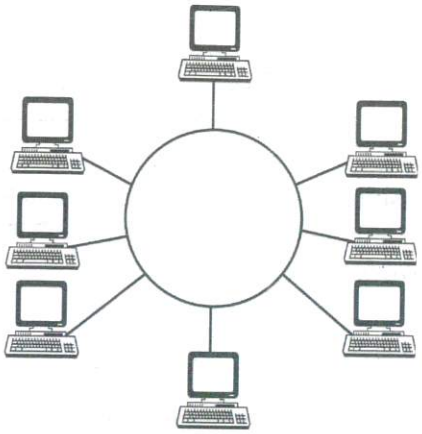

Fig. 3.35 Token Ring Topology

Ring networks with centralized control are known as loops. When ring networks with distributed control are used, some form of control strategies must be used to avoid conflicting demands for the shared channel. The popular control strategies are token passing, circulating slot and register insertion techniques.

Fibre Distributed Data Interface (FDDI)

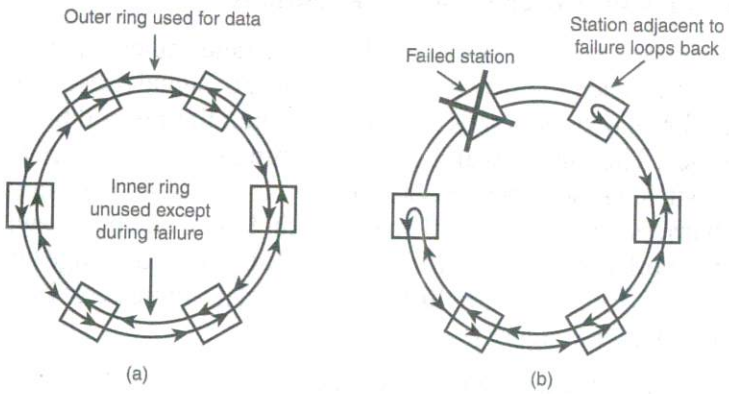

Fig. 3.36 (a) FDDI Network with Counter Ring (b) The Same Network after a Station has Failed

FDDI is developed as a reliable, high-speed network to handle voluminous traffic. It provides data speed at a rate of 100 Mbps and is capable of supporting 500 stations on a single network. FDDI operates on fibre cables by transmitting light pulses which convey information back and forth between nodes. In some cases, it may also operate on copper using electrical signals. A related technology, Copper Distributed Data Interface (CDDI) works like FDDI using copper cables instead of fibre cables.

FDDI is able to maintain high reliability because of the provision of two counter-rotating rings as shown in Figure 3.36(a) in FDDI networks. These rings provide a backup for each other by providing an alternate way to get the data, if something goes wrong in the network. Figure 3.36(b) illustrates data flow when one station fails. When a node fails, the adjoining node uses a reverse path to form a closed ring. FDDI is reliable because it has the ability to fix its own problems.

Mesh Topology

In a mesh network, each pair of nodes is connected by means of an exclusive point-to-point link. Each node requires a separate interface to connect with the other device. Mesh networks are seldom constructed in practice. They are useful in situations, where one node or station frequently sends messages to all other nodes. Otherwise, a considerable amount of network bandwidth is wasted. The advantages are excessive amount of bandwidth and inherent fault tolerance. The structure of a mesh network is shown in Figure 3.37.

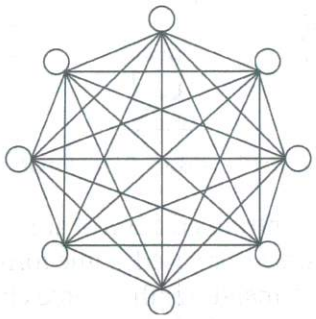

Fig. 3.37 Mesh Network

Switched and Non-Switched Network Options

Switching includes the 'plug and play' element. It determines Ethernet addresses which are used on each segment and creates a table of signal packets. This feature connects different network types together just like Ethernet and fast Ethernet of the same types. The main advantage of switching is that there are no protocol issues with switching. Nowadays, a fibre optic switch is used in switching technology because it harnesses all the available bandwidth. Use of an optical switch allows users on a network to send more information. It also provides huge advantage as immunity to EMI (Electrical and Musical Industries) disturbance and lighting strike which assures network security.

Switching provides gigabit speeds and several management options. Basic management includes the following:

- **General:**– Switching manages location, system name, reboot on error, statistics collection, Telnet login, etc.
- **LAN Port:** Switching configures speed and flow control, link type and physical address, to change configuration on each port.
- **Console:** Switching, at this stage, changes the flow control method , baud rate, modern control, set-up string, enable or disable SLIP (Serial Line Internet Protocol), configure SLIP, SLIP subnet masking.

In switching, file transfer packets allow you to identify the port which is up and the port which is down. The bandwidth option is increased through the trunk technique. Basically, it is the process of hooking one switch to another in full duplex.

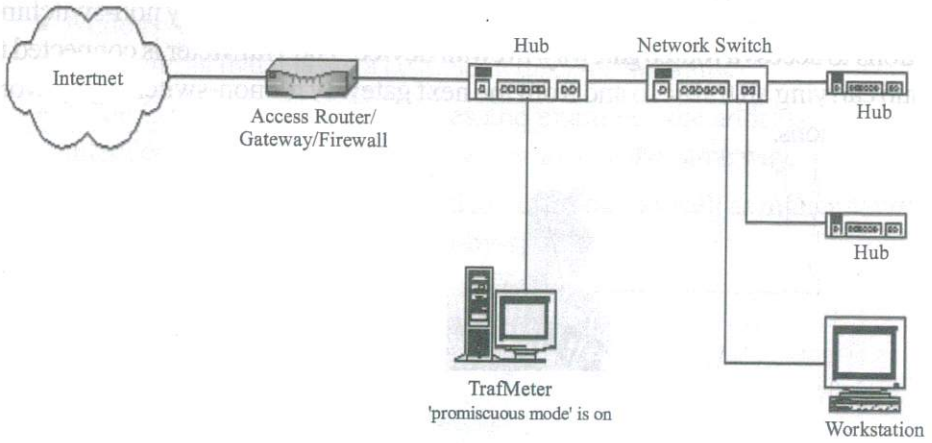

Fig. 3.38 Switched Network

Figure 3.38 shows that in a switched network, a network switch which is also called Ethernet switching, is used in segmenting to reduce network loading. It blocks some data from branches of the network which basically do not require the data.

Advance switching includes many tasks for setting up networking design including the following:

- L2 Switching Database
- L3 IP Networking
- Bridging
- Static Filtering
- Spanning Tree
- SNMP(Simple Network Management Protocol)
- Port Trunking
- Port Mirroring

Non-Switching Options

Non-switching option is used by small organizations. The computer network consists of only one segment to which all workstation computers are connected by a network hub.

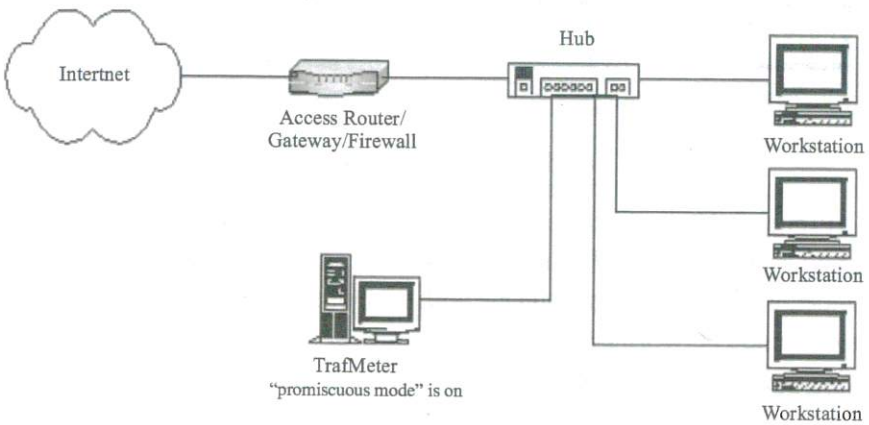

Fig. 3.39 Simple Network Configuration

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Figure 3.39 shows how a segment is connected over a network by non-switching options to access a router/gateway/firewall device. The TrafMeter is connected to a hub carrying all traffic to and from the next gateway for non-switching network configurations.

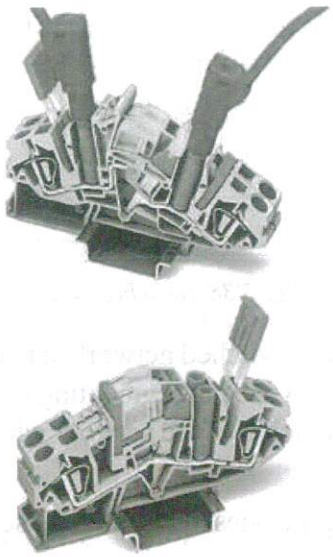

Fig. 3.40 *Pluggable Thermal Circuit Breaker used in Non-Switching Set-up*

In a non-switched network environment, the network segment concept is followed. Segment is a network architecture in which the router, bridge and hub are directly addressable from each node. The main advantage is that frames are handled in a broadcast manner. Each node examines the frame to see if it is addressed to them.

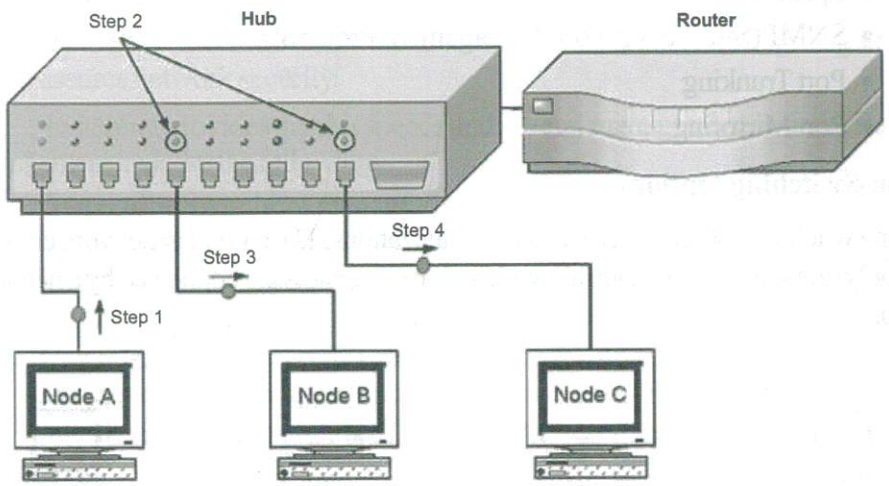

Fig. 3.41 *Non- Switching Set-up*

Figure 3.41 shows how a non-switched network works. Here, Node B is designed as the host which is used as a sniffing agent. Nodes A and C represent the innocent who try to communicate with each other. The normal flow of traffic in a non-switched network is as follows:

- Node A transmits a frame to node C.
- The hub broadcasts the frame to each active port.

- Node B receives the frame and examines the address in the frame after determining that it is not a host. So, it discards the frame.
- Node C also receives the frames and examines the address. If it is the intended host, further frame process is done in the same way.
- Then, network frames are passed to other hosts as well as higher network layers where it is processed step-by-step.

Check Your Progress

12. Differentiate between baseband LAN and broadband LAN.
13. State about the hierarchical topology.
14. What is the distinguishing feature of a star topology?
15. What is a ring topology?

3.14 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Office automation systems is a type of information system that aids in automating office tasks. It has a limited role in decision-making and is more useful for operational-level people.
2. The Transaction Processing System (TPS) is defined as an information system that processes transactions and produces reports that represent the automation of the fundamental, routine processing.
3. Decision Support System (DSS) helps the senior management to take strategic decisions. Contrary to other systems, decision support system is developed with the objective of providing the users (top management personnel) with unstructured information.
4. According to the American Marketing Association, Marketing is an organizational function and a set of processes for creating, communicating and delivering value to customers and for managing customer relationships in ways that benefit the organization and its stakeholders. In simpler words of Philip Kotler, Marketing is satisfying needs and wants through an exchange process.
5. Executive Support Systems (ESS) are designed for senior executives of organizations. Executives are responsible for the growth and survival of the organization. They need to monitor the performance of the organization, remain competitive and respond to market changes and trends, etc.
6. Expert systems offer an economical and practical way to capture, refine and proliferate management skills. These systems provide a framework in which to document the questions and answers that experts use to solve analytical and operational problems. With expert systems, the know-how of one 'expert' can be put in the hands of many workers to improve consistency, accuracy and productivity throughout the network.
7. Channel noise is the background interference present in the channel in small amounts. It can also be the unwanted electrical or electromagnetic energy

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that does not carry any data or information but interferes with the information or data. Hence, noise degrades the quality of information and data by affecting communications and files of all types, including images, audio, text, programs, and telemetry.

8. Channel data transmission rate is determined by the maximum number of bits that can be transmitted per unit time through the physical medium. It is measured in bits per second (bps). H. Nyquist gave the maximum data rate of a noiseless channel in 1924.
9. When signal amplitude degrades along a transmission medium, this is called signal attenuation. When a signal passes over the transmission media and electronic circuitry to finally reach its destination, the signal loses its power or energy. Attenuation is the loss of the signal power of signal while traversing a transmission media including electronic circuitry and is measured in terms of decibel (dB).
10. It is the most powerful computer of the network. There are two types of servers normally employed in a local area network. They are dedicated servers and non-dedicated servers.
11. A workstation is an individual computer capable of communicating with other machines. It must be equipped with the hardware and software necessary to connect to a LAN.
12. A baseband LAN is a single-channel system that supports a single transmission at any given time. Broadband LANs support multiple transmissions via multiple frequency channels.
13. A hierarchical topology connects multiple star networks to other star networks. This type of topology contains a central root node that is top-level hierarchy which is connected to one level lower in the hierarchy. It maintains a point-to-point link at the end of the previous level node. The total number of point-to-point links in a network is based on the physical hierarchical topology.
14. The distinguishing feature of a star topology is that all nodes are joined at a single point.
15. The ring architecture is a distributed architecture, with minimal connectivity and a topology of two links connected to every node.

3.15 SUMMARY

- Office Automation Systems aids in automating office tasks. It has a limited role in decision-making and is more useful for operational-level people. The information derived from this type of system can be used for role-based decision-making by managers at the operational level. This system, however, plays an important role in automating several functions of an office and thus helps in creating paperless offices.

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- This type of system is critical for the smooth functioning of an organization. The objective of this system is to capture all transaction-related data between the organization and its external and internal customers.
- Typically, the transaction-level data is stored in a preformatted manner in a relational database for further action in the future. TPS is the most widely used form of information system, as it provides management with the flexibility of storing data in a structured manner and retrieving it at a later date using the query facility.
- Decision Support System (DSS) helps the senior management to take strategic decisions. Contrary to other systems, DSS is developed with the objective of providing the users (top management personnel) with unstructured information. This system helps the management to develop 'what if analysis', so that different scenarios can be developed for decision-making. DSS deals with both internal and external data.
- DSS helps the management to take decisions that are complex and difficult. It improves the quality of decision-making by helping the decision-maker to make informed choices. It thereby, improves efficiency and improves performance.
- An executive support system (ESS) provides a graphical view of the data. The most challenging part of building an ESS is to transform transactional data into usable form. The data may be incomplete or the required fields may be missing.
- Expert systems include three components: knowledge base, inference engine and user interface. The knowledge base contains the ex-pertise in the form of a series of 'if. . . then' conditions.
- Enterprise resource planning began as a term used to describe a sophisticated and integrated software system used for manufacturing. In their simplest sense, ERP systems create interactive environments designed to help companies manage and analyse the business processes associated with manufacturing, such as inventory control, order taking, accounting and much more.
- In the communication context, signalling refers to the exchange of information between components required to provide and maintain data communication service. In case of PSTN, signalling between a telephone user and the telephone network may include dialling digits, providing dial tone, accessing a voice mailbox and sending a call-waiting tone etc.
- Channel data transmission rate is determined by the maximum number of bits that can be transmitted per unit time through the physical medium. It is measured in bits per second (bps).
- Bit rate is the number of bits (0 or 1) transmitted during 1 second. The number of signal changes per unit of time to represent the bits is called the data rate of the modem. That rate is usually expressed in terms of a unit known as a baud.

- The group of people responsible for monitoring and reviewing the progress made in developing TCP/IP, initiated by US Department of Defense, is known as the Internet Activities Board (IAB).
- In general, a computer network is composed of one or more servers, workstations, network interface cards, active and passive hubbs, routers, bridges, gateways, modem, software components like network operating systems and other application software.
- Networks that are privately owned, offer consistent fast-paced communication channels which are optimized to connect information processing tools in a restricted geographical area. These are known as Local Area Networks (LANs).
- A Metropolitan Area Network (MAN) covers large geographic areas such as cities or districts. By interconnecting smaller networks within a large geographic area, information is easily disseminated throughout the network.
- A Wide Area Network (WAN) connects networks in different cities or countries. Gateways are used to connect these networks. A network which can connect networks that are over a hundred kilometres apart is not built by any organization.
- LANs are classified depending on the topology, access methods, signalling methods, transmission medium and transmission mode.

3.16 KEY TERMS

- **Office automation systems:** This type of information aids in automating office tasks and can be used for rule-based decision-making by the managers at the operational level
- **Decision support systems:** This system aids the senior management in taking strategic decisions and was developed with the objective of providing the users with unstructured information
- **Transaction processing systems:** The objective of this system is to capture all transaction-related data between the organization and its external and internal customers
- **Decision support system:** It is defined as an information system application that assists the managers in decision-making.
- **Channel:** with respect to data transmission, a channel may be defined as a path between transmitter and receiver.
- **Workstation:** It is an individual computer capable of communicating with other machines.
- **Repeater:** It is a communication device that connects two segments of a network cable.
- **Bridge:** It interconnects two networks using the same technology (such as Ethernet or Arcnet).

- **Bandwidth:** It is the range of frequencies assigned to a channel.
- **Router:** It is a device that transfers data between network.
- **Modem:** It provides two-way communication facility between a computer network and telephone network.
- **Local Area Network (LAN):** It is a form of local (limited-distance), shared packet network for computer communications.
- **Baseband LAN:** It is a single-channel system that supports a single transmission at any given time.
- **Broadband LAN:** This supports multiple transmissions via multiple frequency channels.

3.17 SELF-ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. What are the limitations of office automation systems?
2. What do you understand by filing data?
3. Why is TPS required for the smooth functioning of a company?
4. Which support system helps senior management of a company take strategic decisions?
5. Which is the most important component of DSS?
6. State about the digital firms in DSS.
7. Name the components of an expert system.
8. What is the main objective of the ERP?
9. Define the term channel bandwidth.
10. Stat about the simplex and half duplex communication.
11. How do LANs help us?
12. What are the disadvantages of broadband LANs?
13. Differentiate between LAN and WAN.
14. Distinguish between a WAN and a VAN.

Long-Answer Questions

1. Briefly explain the office automation systems and its applications.
2. Explain the term transaction processing systems with the help of diagram.
3. Discuss about the evolution of DSS with the help of diagram.
4. Explain the elements in the model management subsystem.
5. Describe the role and benefits of Executive Support Systems (ESS).
6. Discuss about the expert system as well as enterprise resource planning system.

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7. Briefly explain the concept of communication with the help of appropriate examples.
8. Describe the protocols standards and transmission impairments giving appropriate examples.
9. Why is a network required? Describe the components of a network.
10. List and describe the various network services available nowadays.
11. How a LAN system does helps an organization? Give an example.
12. Discuss the importance of MAN and WAN networks. What are their applications?
13. What are communication networks? Why are they becoming important?
14. Briefly explain the topologies and its types with the help of diagram.

3.18 FURTHER READING

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UNIT 4 TELECOMMUNICATION, PROJECT PLANNING, ANALYSIS AND DESIGN OF MIS

Structure

4.0 Introduction
4.1 Objectives
4.2 Introduction to Telecommunication
4.3 An Overview of System Analysis
4.4 Information System Design
4.5 Planning and Implementation of MIS
4.6 Answers to 'Check Your Progress'
4.7 Summary
4.8 Key Terms
4.9 Self-Assessment Questions and Exercises
4.10 Further Reading

4.0 INTRODUCTION

The important role of telecommunication systems have played in the emergence of information technology. Computers were invented in the 1940s and became an integral part of the commercial world in the1960s. Since then, the growth of this industry has been phenomenal. Initial computers were built using vacuum tubes that have now been replaced by microprocessors. Nowadays, computers and other computing devices are extremely user friendly and can be carried around. Computers are also networked through the use of different communication media. Computing power of computers has been growing at a faster rate than its usage. They can process multimedia data such as sound, voice, still images and video images.

Structured data analysis (systems analysis), analysing the flow of information within an organization with data-flow diagrams. Systems analysis is 'the process of studying a procedure or business to identify its goal and purposes and create systems and procedures that will efficiently achieve them'. Another view sees system analysis as a problem solving technique that breaks down a system into its component pieces, and how well those parts work and interact to accomplish their purpose. Systems design, the process of defining the architecture, components, and data of a system to satisfy specified requirements.

In this unit, you will study about the introduction of telecommunication, overview of system analysis, information system design, planning and implementation of MIS.

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4.1 OBJECTIVES

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

- Understand the introduction of telecommunication
- Explain the overview of system analysis
- Define the information system design
- Discuss about the planning and implementation of MIS

4.2 INTRODUCTION TO TELECOMMUNICATION

Most information systems used today require networking and communication technology. This revolution has been possible due to the Internet which is a network of networks. Each of the constituent networks is owned by a different organization. Some networks are in the public domain. These constituent networks are spread over 200 different countries across the globe and more than 6 billion people (according to 2008 data) use the Internet. The Internet has transformed the shape and form of business enterprises.

'Information superhighway' was a popular term used through the 1990s to refer to digital communication systems. It is associated with Al Gore, the then US senator and subsequently the Vice President, who had been involved with computers since the 1970s. Gore could perceive the role telecommunications was to play in commercial and educational systems. He provided the intellectual, political and financial support required for the growth of telecommunication systems. The Internet is extremely flexible; a network can join the Internet and leave without affecting the overall network. All that is required is an **IP address** (explained later) from a service provider to join the Internet.

The marriage of communication and computers has greatly improved the flexibility of computer systems. Consequently, managers have gained access to information on the latest development in manufacturing technology, management and the servicing industry. A manager can study all options and pick the most suitable option. Before the Internet, information was difficult, time consuming and expensive to access. In an academic environment, a Ph.D. student needs to read at least a hundred research papers in his area of research. This activity took about one and a half years, and the most time-consuming part was the collection of the relevant papers. With the Internet, researchers can sit at their office/desk and read research papers online and print the ones they finds relevant. The amount of non-productive component, cost and time has reduced greatly. The Internet supports multimedia data. There are search engines such as Google, Yahoo, etc., that facilitate the search of information and documents. An individual or a group of individuals or an organization, wishing to share information, can create a Website, get an IP address from a service provider, an Internet connection and go public. The whole effort can be completed in a few days' time.

Components and Functions of a Telecommunication System

Telecommunication is the communication of information by electronic means, usually over some distance. Previously, telecommunication meant voice transmission over telephone lines. Today, a great deal of telecommunication transmission is digital data transmission, using computers to transmit data from one location to another. Telecommunication systems can transmit text, graphic images, voice or video information.

Telecommunication System Components

A telecommunications system is a collection of compatible hardware and software arranged to communicate information from one location to another. A network system consists of hardware components as well as software components. The following are the essential components of a telecommunication system:

- ***Server or Host Computer*:** This is the computer at one end of the transmission system that has data to transmit.
- ***Client*:** This is the computer at the other end of the transmission system. It receives the data transmitted by the server.
- ***Network Interface Card (NIC)*:** This is the interface between the network cable or transmission system and the computer. Earlier, an NIC had to be bought separately and installed in the computer. Nowadays, the NIC has become a standard component of a computer system.
- ***Circuit or Transmission System*:** The circuit is the pathway through which data travels between a client and a server. The circuit may be a copper wire or an optical fibre. The commonly used media are Unshielded Twisted-Pair (UTP) cables, Shielded Twisted-Pair (STP) cables and coaxial cables. A cable has little cable connectors at both ends. One connector is plugged into the computer and the other one is connected to the **switch** or **hub**. Each type of cable has restrictions on its maximum length. The distance between the computer and the hub or switch is limited by the type of cable used to connect the two. The cost of each of these cables is also different. As an example, a UTP-CAT5 wire can be 200 metres (maximum) long with RJ45 as the cable connectors. The cost of the cable is approximately Rs 20 per metre. Nowadays, fibre optic cables are being used in place of copper wires. Fibre optic cables can withstand higher temperatures and have much higher bandwidths. Communication takes place through a wireless medium. Microwaves are also used for data transmission.
- ***Network Hubs and Switches*:** Hubs and switches are used to connect cables. A hub is a simple device that broadcasts an incoming message on all its ports. Hubs come in 4, 8 and 16 port sizes. An 8-port hub can connect 8 systems to the central cable. Earlier, computers were connected using hubs, which have now been replaced by switches. A switch has more intelligence (circuitry) and knows the ports of the computers that are connected to a LAN. An incoming message is transmitted only through the appropriate port. Hubs are inexpensive as compared to switches. Each computer is connected to a switch by a network cable.

- ***Network Operating System (NOS)*:** In addition to the hardware, there is always a special purpose network software that makes the hardware work. NOS is the software that controls the network. It has software for the server as well as the client. Novell NetWare is one of the oldest NOSs. Novell supports a wide variety of topologies, protocols and computers. Microsoft Windows NT and Linux are two other very popular NOSs and are growing rapidly.

Cellular telephones work by using radio waves which communicate with radio antennae (towers) placed within adjacent geographic areas called *cells*. A telephone message is transmitted to the local cell by the cellular telephone and then passed on from antenna to antenna—cell to cell—until it reaches the destination cell where it is transmitted to the receiving telephone. Older cellular systems were analog in nature while the newer cellular systems are digital in nature.

Newer models of digital cellular phones can handle voice mail, e-mail and faxes, save addresses, access a private corporate network and information from the Internet as well as provide wireless voice transmission. These **smart phones** are equipped with Web browser software that lets digital cellular phones or other wireless devices access Web pages formatted to send text or other information that is suitable for tiny screens. Some smart phone models offer larger screens and keypads to make Internet access easier.

Data cannot be transmitted seamlessly between different wireless networks if they use incompatible standards, for example, digital cellular services may use Code Division Multiple Access (CDMA), Global System for Mobile Communications (GSM) or Time Division Multiple Access (TDMA) technology, which are not compatible with each other.

4.3 AN OVERVIEW OF SYSTEM ANALYSIS

System analysis is a process in which data is collected and then interpreted to identify problems within the system. After interpretation, problems are identified. Therefore, the collected information can then be used to recommend improvements in a system. In other words, system analysis includes identifying, understanding and examining a system so that the objectives of the system can be achieved. The pre-determined objectives of the system analysis include:

- Knowledge of the system operation
- Identification of the user requirements in the proposed system

The system analysis stage investigates the system operations and determines the solutions to solve the problem. Therefore, system analysis is considered a logical process.

System analysis is really vital in the completion of the development process of a system. It may be possible that a user is aware of the problem but may not have the solution. In such a scenario, a system analyst works with the user so that a logical model of the system can be developed. A system analyst from a technical background may move too quickly to the program design stage in order to make

a system more physical. This approach is not desirable and should be avoided because it can affect the ultimate success of the system. A system analyst can work with a user to obtain a complete knowledge of a system. For complete information about a system, a logical model of the system is developed, based on a detailed study of the system. A detailed study should involve various modern tools and techniques, which include data flow diagrams, data dictionary and rough descriptions of the relevant algorithms. A set of system requirements for a proposed information system is the final product of the system analysis stage.

Requirement Analysis

The basic understanding of a system can be developed by analysing the requirements of the system. The requirements tell us the need for the system, the users of the system, the problem that the system is being created to solve, etc. In short, it gives us a lot of information about the functional nature of the system and hence it is very important to thoroughly analyse the requirements, so that there is no gap in the analysis.

Requirement analysis is a formal process of interacting with a client to understand and establish the requirements of the client in a formal document. It involves the use of fact-finding techniques and a keen eye for detailed information to find the underlying cause of an issue. Sometimes, the client may not be sure of the requirements. The requirement analysis process should take the client through a journey by which the client is able to articulate the requirements clearly. The client may look at the requirements from a superficial angle, thereby identifying the symptoms of the problem as requirements instead of analysing the source of the problem. The requirement analysis phase helps to structure the process of requirement analysis highlighting the actual requirement of the client.

While initiating the process of requirement elicitation and analysis, some key issues must be understood so that this analysis is easier. The key issues from the perspective of the developers are as follows:

- The key people driving the request. This will help them to focus their information collecting activity on these people, so that the actual nature of the requirement becomes evident.
- The key people who will use the system. This gives the development team an understanding of the user profile.
- The financial benefit. This gives the requirement elicitation team an understanding of the financial benefit that is expected from the solution.
- What according to the user is a good solution? This gives the team an idea of the expectation from the system by the user.
- What is the problem that the system will address? This gives the team the reason for the development of the system.

A series of client interactions result in the preparation of a system requirement specification document, which is then used for designing the system.

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Analysis principles

The key principles on the basis of which analysis is done are as follows:

- **The information domain of the problem is to be given due regard:** This means that the domain of information in which the problem operates has to be appreciated.
- **The key functions of the system have to be defined:** The key functionality of the system has to be defined clearly.
- **System must be modular:** This is required to help create the system in a faster way.
- **System has to be defined in an abstract term:** This helps reduce complexity.
- **Reduce ambiguity:** The ambiguity in the system must be reduced to enable the system designer to clearly focus on the outcome.

System Requirements Specification (SRS)

This is a formal document that is created to capture the requirements of the system. It should have the following descriptions:

- **Information description:** A detailed information description.
- **Functional description:** A description of the functionality required from the system.
- **Validation description:** This is the data validation and business rule description required in the system.

SRS is a formal document and the entire process of system development depends on this. SRS is also a matter of negotiation between the client and the developer as there may be differences in the understanding of the requirement. IEEE and ANSI have set guidelines for SRS.

Requirement Determination

It is essential to determine the requirements of a system for the system analysis process. The requirement determination is the preliminary step of the system development activity and is also known as software requirement specification (SRS). The requirement determination activity is the most difficult activity involved in the development of a system. Since there is a communication gap between a user and a developer, this activity is more prone to errors. The communication gap arises because the user usually may not understand the software of the organization or the developer may not understand the user's problem and application areas. To bridge the communication gap between the user and the developer, *requirement determination* is introduced. This requirement determination process provides a means of translating the ideas given by a user, into a formal document. The benefits provided by a good SRS are as follows:

- It bridges the communication gap between a user and a developer.
- It reduces the development cost as it overcomes errors.

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- It acts as a basis of reference for the system, so that it can validate the final product.

Requirement determination consists of the following activities:

1. **Requirement anticipation:** This activity includes the past experience of the system based on a study performed on the existing system. It also predicts the possibility of certain problems and requirements for a new system.
2. **Requirement investigation:** This activity is central to the system analysis process. In this activity, the existing system is studied and documented for further analysis. For this purpose, various methods such as fact-finding techniques are used.
3. **Requirement specification:** This activity involves the analysis of the data that was produced during the fact-finding investigation in order to determine the requirement specification.

We can conclude that requirement determination involves the following information:

- The general process
- The data produced during the process
- Various constructs in terms of time and volume of work
- The performance controls applied in the system

These activities are further elaborated in the following section.

Understand the process

The basic step in the requirement determination activity is the knowledge of the process. The process can be well understood if the information collected includes:

- The purpose of the business activity
- The steps involved in the activity
- The persons performing those activities
- Other information such as the frequency, time and user of the resulting information

Identify the data used and the information generated

After understanding the process, the system analyst should look for the data that is required to perform each activity discussed in the previous step. For example, in an inventory system, a buyer may require data describing the quantity of an item, supplier name, item cost and demand for the item.

Determine frequency, timing and volume

After the identification of data, information is collected so that it can be identified how often an activity is repeated. It also determines the number of items that can be handled in each activity. Similarly, time is another constraint while evaluating certain steps of an activity.

Know the performance controls

The determination of performance control is important in the requirement determination activity as it enables the system analyst to understand how business functions can be maintained. It allows the system analyst to gather information during system investigation. The information in this phase can be gathered mainly from the personnel and the written documents of the organization. The written documents include financial reports, personnel documents and various other documents such as transaction documents and manuals.

It should always be kept in mind that the personal managerial attributes of an individual manager and an organizational environment affect the information requirements of the proposed system. Personal attributes may include the manager's knowledge of information systems, managerial style and his perception of information needs. On the other hand, organizational environmental factors may include nature of the company, level of management and structure of the organization.

Strategies for Requirement Determination

There are certain strategies for requirement determination that allows a system analyst to understand the existing system and also to determine the information requirement. Various strategies that solve the purpose are described below:

Interview

The interview strategy follows a method in which a user and a developer interact with each other to collect the required data. In this method, the developer poses questions to the user and based on the response given by the user, the developer finds some solutions. The interview can be formal or informal and the questions asked may be structured or unstructured. This method is helpful for gathering information from individuals who may be weak in written communication or who may not have the time to answer questionnaires.

This strategy is the oldest and the most often used device for gathering information about an existing system. Though it is one of the preferred techniques, it is not always the best source of application data. This is because the users are sometimes unable to explain the system in detail. This process is time-consuming and hence other methods are used to gather information.

It is important that the system analyst must be trained in interviewing the personnel, as the success of an interview depends on the skill of the interviewer and on his or her preparation for the interview. Hence, it is important for a system analyst to plan the interview. A system analyst must have the following information before the interview:

- The person to be interviewed
- The time of interview
- The questions to be asked
- The venue of the interview
- The initiation point of the interview
- The termination point of the interview

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The advantages of interview can be summarized as follows:

1. Useful in exploring issues of an undefined nature and complexity.
2. Useful in gathering more information in less time.
3. Useful in knowing the reactions and responses of the respondents.

Questionnaire

A questionnaire is a method that involves a set of questions to which an individual needs to respond. This strategy allows a system analyst to gather information regarding different aspects of a system among a large number of persons. This strategy provides more reliable data in comparison to the other fact-finding techniques, such as, interviews and focus groups. In addition, a questionnaire is less time consuming as compared to interviews. The downside of a questionnaire is that sometimes it becomes difficult to design exhaustive questionnaires. In addition, the expressions and reactions of respondents cannot be observed through a questionnaire but can be observed easily during an interview. Questionnaires need to be tested and modified by the interviewer based on prior questionnaires and the experience and background of the respondents.

The advantages of a questionnaire can be summarized as follows:

1. Respondents could hide their identity if they do not want to reveal it.
2. It is an efficient way of collecting information through paper documentation or through the Internet.
3. It is less time consuming.

Record review

The record review strategy is also known as review of documentation strategy. The main purpose of this strategy is to find the quantitative information regarding constraints such as volumes, frequencies and ratios. A system analyst examines the information that has been recorded about a system and its users. The records include manuals, regulations and standard operating procedures of an organization. The records act as a guide to the managers and other employees. To study and understand the existing system, records prove to be helpful for the system analyst.

The limitation of this approach is that the records may not be completed or updated. An existing system can be viewed in two different views. One such view that favours the study of the existing system states that the shortcomings associated with an existing system can be learned. This knowledge of shortcomings is then further used and therefore, the common mistakes can be identified and avoided.

Another view argues that new ideas cannot be generated and the developer must follow the logic associated with the old system. Both the views seem valid and therefore, it is difficult to comment upon each view.

Observation

Observation is also one of the strategies used for gathering information. This is a process in which people, object and occurrences are recognized and noticed in order to collect information from sources. The information collected using this strategy is useful when a system analyst needs to observe the way in which the records are handled, processes are carried out and whether the specified steps are actually

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followed. The drawback of this strategy is that an observer may not be able to gather all the required information. Moreover, the method used in this strategy is time-consuming and costly. Electronic observation and monitoring methods are widely used as information gathering tools because of their speed and efficiency.

A system analyst uses a combination of all the approaches to study an existing system because one approach may not be sufficient for gathering the required information of the system.

Tools for Structured Analysis

The above discussed fact-finding strategies represent only one aspect of system analysis. These strategies do not provide any mechanism that can help in organizing the details collected in each phase of the system analysis process. The information collected needs to be organized. Various tools that can be used for organizing information are known as structured analysis tools. These tools help a system analyst to document the system specifications of a system. These tools are:

- Data Flow Diagram (DFD)
- Data Dictionary
- Structured English
- Decision Trees
- Decision Tables

These tools are described in further detail in the following section.

Data Flow Diagram (DFD)

Data flow diagram is a tool that helps in expressing the system requirements in a simple form. It provides a graphical representation of the logical flow of data. This tool is also known as a *bubble chart*. The purpose of data flow diagram is to simplify the system requirements. DFD is responsible to decompose the requirement specification in each stage of the system analysis process. Lines that represent data flow in a system can join the information or data. The main symbols that are used in DFD are as follows:

- **Square:** This symbol is used to represent the source or destination of system data. Figure 4.1 shows the square symbol.

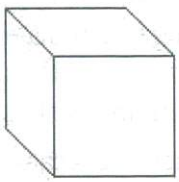

***Fig. 4.1** The Square Symbol*

- **Arrow:** This symbol is used to identify the data flow. The arrow specifies a pipeline through which the data flows. Figure 4.2 shows the arrow symbol.

***Fig. 4.2** The Arrow Symbol*

- **Circle/Bubble:** These symbols are used to represent a process that transforms incoming data flow into outgoing data flow. A process can be represented by a circle or an oval bubble. Figure 4.3 shows the circle symbol.

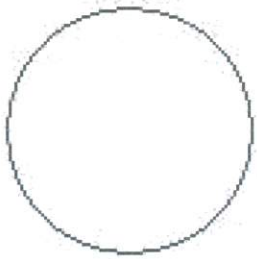

Fig. 4.3 The Circle Symbol

- **Open rectangle:** This symbol is used to represent a data store. Figure 4.4 shows the open rectangle symbol.

Fig. 4.4 The Open Rectangle Symbol

There are certain rules that need to be followed while drawing a DFD. These rules are as follows:

1. The processes must have a name and number associated with it. The name of the process represents the process.
2. The direction in which the data flow is represented should be from top to bottom and from left to right.
3. A proper numbering of processes must be maintained. This means when a process is exploded into lower levels, the exploded processes can be easily identified. For example, process 1 is exploded to further processes, which should be numbered as 1.1,1.2 and so on.
4. The name of the data stores, sources and destinations should be written in capital letters. The name of the process and data flow must have first letter capitalised.
5. The data flows should not intersect.
6. Looping is not allowed. This means that the data flow out of process A going to process B cannot come back to process A from process B, without going through another step in between.
7. Entities should not directly access data stores. They should go through a process.
8. Data flows cannot be orphan data flows, which means that they must terminate to a process or an entity of a data store or another DFD.

Logical DFDs are more popular and physical DFDs are rarely used.

It is important to note that a DFD can contain 10–12 processes. The DFD is just a graphical representation of data flow and therefore, it should have minimum

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content of a data store. This tool is very effective when the required design is not clear and the user and analyst require some symbolic representation for communication.

The concept of DFD can be explained with the help of an example. Consider the example of a library management system to issue books to each student of an institution. Figure 4.5 represents the data flow for the library management system.

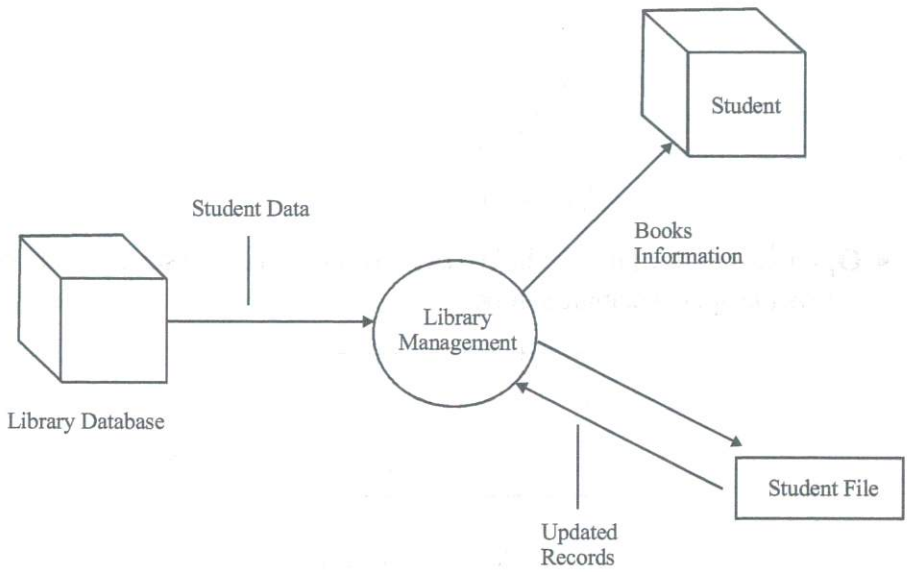

Fig. 4.5 *A DFD for Library Management System*

The student data originates from the library database and acts as a source. The data is then processed and the students receive the information regarding the books. The updated data on students is stored in an intermediate file known as the data store and is required for processing in the subsequent months. The drawback of this approach is that it requires a large number of iterations to arrive at an accurate and complete solution.

DFD is a powerful tool to understand the functional and informational perspective of a system. It can be of two types—logical data flow diagram and physical data flow diagram. Logical data flow diagram deals with the functional view of the system and defines the system in terms of its functionalities and information flows. It uses the following symbols for such representations:

An entity is represented by this:

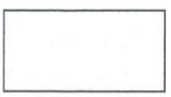

Fig. 4.6 *An Entity*

Figure 4.7 illustrates a curve which represents information flow from one entity or process or data store to another.

Fig. 4.7 *Information Flow from One Entity or Process*

Figure 4.8 illustrates two parallel lines which represent data store.

Fig. 4.8 Data Store

Figure 4.9 illustrates a process which is represented by a circle.

Fig. 4.9 A Circle

Figure 4.10 illustrates a DFD of a cheque deposit system.

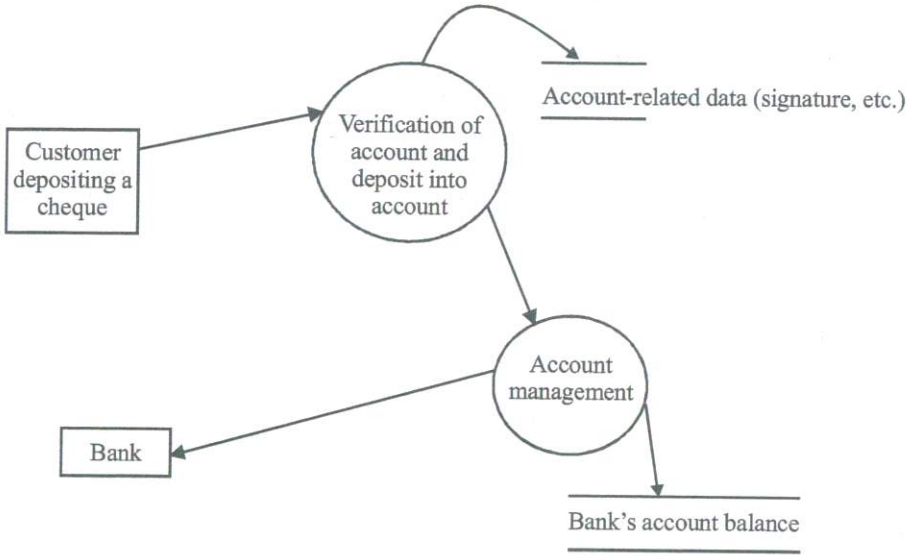

Fig. 4.10 Cheque Deposit System

A DFD can be represented in levels of detail. The abstraction provided by a DFD helps in understanding the system. The top-level DFD is called level 0. All the processes of a DFD are numbered and named. All entities, data flows and data stores are named. A DFD is hierarchical in nature and the top-level DFD is called a context diagram. A DFD further breaks down the levels of abstraction and complexity, until the atomic level is reached and no more granularity is possible. According to the numbering convention for processes in a DFD, the level of the DFD comes first, followed by a dot and then the number of the process. If the process is a subprocess, then this goes on until the process number unique to the process is given.

Data dictionary

A data dictionary is a structured repository of data that defines the basic organization of a database. The data dictionary contains a set of precise and accurate definitions of all the DFDs, data elements and data structures.

A data dictionary makes accessing of data more simple, as it supports documentation in a better way. The data dictionary does not contain any actual data from the database. It only provides precise and consistent definitions for

various data elements, terms and procedures. It also helps in improving communication between a user and a system analyst. It serves as a common database for programmers and can also be used for control purposes. The data dictionary is a desirable feature for most of the databases.

The data items present in a data dictionary include:

- ***Data element:*** The smallest unit of data that cannot be further decomposed.
- ***Data structures:*** A group of data elements that are handled as a single unit. It contains a number of data elements as its fields.
- ***Data flows and data stores:*** Data flows are the data structures in motion and data stores are the data structures in rest. Data stores are the locations where the data structures are temporarily stored.

Table 4.1 explains the different symbols used in the data dictionary.

Table 4.1 *Symbols Used in Data Dictionary*

Symbol	Meaning
=	Is equivalent to
+	Add
[Option 1 Option 2]	Only one of the options is used at a given time
Max {Component}	Highest possible number of iterations. Component is optional
Min{component}	Lowest possible number of iterations. Component is optional
* Comment *	Words included within asterisks are considered as comments

You need to follow certain rules while constructing a data dictionary. The rules are:

- The terms used to describe the data structures should always be in capital letters.
- Multiple word names must be hyphenated.
- Assigned names should be straight forward and user-oriented.
- Every data flow, data store, data structure and data element must have a name associated with them.
- A consistency check should be performed.
- The processes must have their identification numbers and names that must be mentioned in the data dictionary.
- Assumed names of the processes must be discouraged.

It is important to note that the data dictionary and DFD are correlated and the data should be presented in a specification. A data dictionary does not provide functional details and therefore, is not much acceptable among non-technical users.

This is another tool used in the design of systems. A data dictionary includes a complete and comprehensive definition of all the data elements in the system. It is the source document for specifications of all inputs, protocols, outputs, data structures, database structures, metadata and algorithms. It is a data repository of all design data about the system. Several description formats are available. One such format requires that for each data item, the following information must be stored in DD:

Name: Formal name of the data item/control item according to the convention used.

Alias: Any other name for the same item.

Use: Where the data/control item is used, by which process, when and for what purpose.

Description: Standard description of the item.

Additional information: Any other information critical for the item.

A well-constructed DD is very useful not only for design but also for posterity. When the system breaks down for some reason, a DD sometimes comes to the rescue.

A DD normally serves the following purposes:

- A summary of the documentation
- A tool to reduce redundant data
- A background for I/O design
- A centralized control of all data in the system
- A controller of data integrity

Decision tree and structured English

A process can be represented using a decision tree as well. Similar to DFDs, a tree is formed in this graphic representation. The logic of the process that is not understood by data dictionary can be made clear using a decision tree. A decision tree has as many branches as many logical alternatives are there. It is easy to construct, read and update. Figure 4.11 shows the decision tree.

The logic can also be represented using structured English. Structured English uses logical construction and imperative sentences that are designed to carry out instructions for actions. In structured English, decisions are made using if-then-else statements.

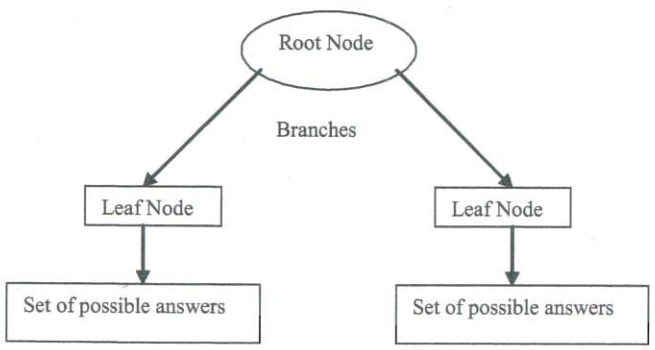

Fig. 4.11 Shows the Decision Tree

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Structured English consists of:

- Sequences of instructions (action statements)
- Decisions (if-else)
- Loops (repeat-until)
- Case
- Groups of instructions

Decision trees can be used to verify logic in problems that involve few complex decisions. However, its biggest limitation is a lack of information due to its structure.

Decision table

A decision table is a compact way to represent complicated logic. It is a matrix that contains rows and columns representing conditions and actions. Decision tables are used in situations where complex branching routines are required.

Decision tables are divided into four quadrants. Table 4.2 shows a decision table.

Table 4.2 Decision Table

Conditions	Condition alternatives
Actions	Action entries

The above shown table describes a decision table in which the following quadrants are included:

1. ***Conditions:*** These are at the upper left corner in the table. The questionnaire is listed in the conditions.
2. ***Condition alternatives:*** This section is at the upper right corner and contains answers to the questions that were asked in the conditions column.
3. ***Actions:*** This section is at the lower left corner in the table and it outlines the action that is required to perform in order to meet each condition.
4. ***Action entries:*** This section is at the lower right corner in the table. It indicates the appropriate action, resulting from the answers to the conditions in the condition quadrant.

There are certain rules that must be followed for constructing a decision table. These rules are:

- A name should be given to each decision that has to be written at the top left of the table.
- The logic should be independent of the sequence in which the condition rules were written, but the actions take place in the order in which the events occur.
- There should be a proper usage of consistent and standardized language.
- Duplication of terms should be avoided to the maximum extent.

Check Your Progress

1. Which US politician played a major role in the creation of the information superhighway?
2. What is a host computer?
3. State about the system analysis.
4. What is Software Requirement Specification (SRS)?
5. Define the term data dictionary.

4.4 INFORMATION SYSTEM DESIGN

Objectives of System Design

System design is an important step in the system development process. This phase comes into existence after the system analysis is completed. This means the output of the system analysis phase provides an input to the system design phase. In other words, the requirement specifications provided by the system analysis is used in the system design phase of the system development process. The identification of data requirements include:

- Identifying data sources
- The nature and type of available data
- Data gaps

The design of a system must adhere to the following objectives:

- **Practicality:** This objective notifies that the design of a system should be user-oriented. This means the users of the system can easily learn and operate the system.
- **Flexibility:** The flexibility of a system design describes the dynamic nature of a system. In other words, a system must be designed in such a way that the system may respond to the changes requested by the users.
- **Integrity:** The integrity of the system design requires use of specific practices and processes such as requirements tracing and verification and validation. The integrity of the system allows the system design phase to be easily integrated with other phases of the software development, to carry out the system development process.
- **Reliability:** The reliability of the system design describes the dependency on the system design for any system errors and faults, in order to analyse the time period of the existence of the system.
- **Efficiency:** Efficiency is highly important while designing a system. A system must perform its jobs within a specified time period. The efficiency of a system can be measured based on the following features:
    - ***Throughput:*** is the rate at which a system performs its jobs per unit time.

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- ***Response time:*** is the time taken by a system to react to a given input.
- ***Run time:*** is the ability to undertake a complete job within a specified time limit.

- **Security:** The security of a system includes:
  - The hardware reliability of the system
  - Physical security of data
  - Detection and prevention of exploited data

The system design phase is carried out at two levels:

(i) Conceptual level or conceptual design

(ii) Physical level or physical design

Principles of Design

The fundamental principles of design are as follows:

- **The first principle of a good design is that it should have an overall macro view of the system rather than a tunnel view:** This helps the designer to fit the components and integrate them in the overall design. The designer will have a comprehensive view rather than only a problem-solving view.
- **The design process should be logical:** The design should have steps, which blend logically. The relationship of logic in the process of design should be unidirectional and strong.
- **The design should not reinvent the wheel:** The design should not tread into territories, which have already been confirmed. The idea is not to revisit an issue unnecessarily.
- **The design should be a very close abstraction of the problem:** The design should make a clear abstraction of the problem it is supposed to solve.
- **The design should be uniform and integrated:** The design should be uniform throughout and integrated, without having loose components which do not have any linkage with the system.
- **The design should be structured:** The design has to be structured in order to be of value to the developer. The process of design itself and the output from the design process will have to be structured.
- **The design should be reviewed on a real-time basis to minimize errors:** The design should not be allowed to proceed unreviewed. While accepting the fact that design is a creative endeavour, the process around design should be such that mistakes in the design should be identified before more time is spent on creating more design around the mistake.

Concepts of Design

Some major design concepts that are to be adhered to in designing the system are as follows.

Abstraction

Abstraction is the conceptualization of an issue or problem or entity in terms of some level of generalization, without regard to irrelevant low-level details (Wasserman, 1983). At the top level, abstraction is used in broad terms and defined with the variables of the environment; however, at the lower levels, it is defined in problem-oriented, procedure-oriented and implementation-oriented terms. Several types of abstraction are possible at the lower level. They are as follows:

- ***Procedural abstraction:*** When abstraction is used to define procedural issues. It is a named collection of several sequential procedural steps.
- ***Data abstraction:*** A set of data that defines an object.
- ***Control abstraction:*** A named control mechanism, which has several steps.

Refinement

Refinement is a top-down design strategy in which the design is refined after successive steps. In each step of refinement, greater detailing is done in the instructions. Refinement helps the designer in elaborating the systems and identifying low-level details as the design progresses.

Modularity

Modularity is a very important concept for any system design. It helps the designer to compartmentalize the design into functional compartments as the entire system can be conceived to be composed of a set of modules, each having its own special feature and functionality rather than a monolithic entity. Modularity helps the designer to comprehend the system better. However, the division of a system into modules comes at a cost. If modules increase in number, then initially the cost/effort per module for creating the system decreases as less dependencies make the system less costly; however, the cost of integration rises. Thus, the total cost reduces initially but then rises. Therefore, any system should be divided into an optimum number of modules, so as to keep the cost low.

Effective modular design in general, reduces the complexity of the system by dividing the system into easily understandable modules. These modules, in order to be effective, must exhibit a functional independence, cohesion and coupling. Functional independence in a module means that the module is focused on the delivery of some output, in a functionally independent manner. It does not interact with other modules a lot to achieve this goal. Functional independence make the modules easier to create, maintain and reuse. They work like components in an engineering application, each module performing a task with minimum interaction with other subsystems. These types of modules are easy to create and develop. Cohesion is the degree of singularity of purpose in a software procedure. Coupling is a measure of interconnectivity of modules.

Conceptual Design

The conceptual design stage allows a system analyst to choose an effective information system from among different management information system designs. This design stage determines the feasibility of the management objectives that are accomplished. The conceptual design is also known as external design or high-level

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design. This high-level design becomes a basis for the detailed design of the information system. In other words, we can say that a conceptual design is a prerequisite for the detailed design. The steps involved in the conceptual design are:

1. Problem definition
2. Set system objectives
3. Constraints identification
4. Determination of information requirements
5. Determination of information sources
6. Development of designs
7. Conceptual design documentation
8. Preparation of report

A brief discussion of these steps will make the concept clear.

1. Problem definition

The first step in the conceptual design of an information system involves the problem definition. It is important to understand the definition of the problem before implementing the information system. The function of information system is to solve problems related to information requirements for the organization. It is important to note that in the problem definition step, not only the current problems are considered, it also deals with the long-range planning of an organization, so that future problems also get resolved. The information requirements of an organization are identified and then determined by understanding the objectives and strategic plans of the organization.

2. Set system objectives

After the problem definition step, a system analyst must set the system objectives. The system objectives are always set with the help of the users. This is because the value of an information system lies in the benefits of the users. Setting the system objectives is not a straightforward process and hence, a system analyst needs to consider specific objectives. Once specific objectives are set, they help an organization in improving the efficiency of the information system. However, it is quite difficult to set the real objectives of an information system. Such circumstances should be avoided in which the objectives of an information system are set in vague terms. In other words, the objectives such as keeping accurate records, maximum efficiency, reduced costs and quality information should not be considered as specific objectives.

It is also important that the system objectives must be defined in such a way that they can be easily achieved by the system. In addition, the system provides a measure of performance. In other words, the system objectives should be stated, as far as possible, in quantitative rather than qualitative terms.

3. Constraints identification

System constraints, also known as problem boundaries, are essential for the conceptual design of a system because the identification of constraints helps the system designer in considering the limitations that restrict the design of the system. These constraints help in designing a system that meets the specified objectives. In

addition, a constant review of the objectives is necessary. System constraints can be classified into:

- ***External constraints:*** These constraints are external to an organization. This category includes constraints posed by the customers, government and suppliers.
- ***Internal constraints:*** The constraints that are internal to an organization are known as the internal constraints. The constraints within the organization include:
  - o Non co-operation and lack of support from the top management
  - o An unfavourable organizational policy
  - o Resource constraints such as manpower, time, and money

4. Determination of information requirements

For an effective design of the information system, it is important to understand the information requirements of the users. This step focuses on the identification of the information requirement that helps the management of an organization in performing their functions. A user must specify the following requirements:

- What are the expectations of the user from an information system?
- The information required in achieving the predetermined objectives.

It is the responsibility of the system analyst to adopt an approach that can help in achieving the information requirements of the system. There are two approaches for extracting information requirements: direct and indirect.

The direct approach allows a system analyst to ask various responsibilities of the users. This is followed by certain information that is required to execute each of the specified responsibility. On the other hand, the indirect approach avoids direct questions. A system analyst in the indirect approach asks a user to describe the decision-making process that helps in the system development process. An indirect approach is considered to be simpler, as the user is familiar with his/ her job and can easily describe the decision-making process.

Similar to the system analysis process, several approaches to system design include interviewing the users, using questionnaire, record review and observations. Also, it is required for the system analyst to arrive at a thoughtful decision for adopting the best approach.

5. Determination of sources of information

As the determination of the information requirement is essential, similarly, the determination of the information source is also important. The determination of information source identifies the input data along with the information, such as the timing and format of the information source. The main information required by most of the information systems can be managed within the organization. The information that can be managed within the organization includes internal records, books, statistical and accounting documents. A study of the existing system is quite helpful in determining the information source. The classification of information sources of a system includes:

- ***Internal and external records:*** Internal records can be in a written form such as files, inputs and outputs, reports and documentation. On the other

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hand, external resource may include trade publications and government statistics.

- ***Managers and operating personnel:*** This classification is an important source for understanding input, output and data processing requirements of an information requirement. Information in this classification can be gathered by conducting interviews of the managers and the operating personnel.

After the information sources and information requirements are determined, the next step is to match the information requirements and sources. This can be done using a matrix diagram, which is considered as a valuable means for the integration of sub-systems and for the remaining system design process. Table 6.2 shows the information requirements and information sources matrix.

6. Development of designs

The next activity includes the development of different designs in the conceptual design process. In this activity, a system analyst must know the overall structure of the information system that has to be designed. It is important to note that a conceptual design provides an overview or a sketch of the structure of an information system. The conceptual design further guides and restricts the detailed design of an information system. The development stage of the conceptual design process defines the following areas:

- The decision points
- The flow of information
- The channels of information
- The role of users

Table 4.3 *The Information Requirements and Information Sources Matrix*

Information Requirements ↓

Annual requirements	X		
Consumption Rate		X	
Ordering Cost		X	
Delivering Cost	X		
Unit Price			X
→	Production	Accounting	Purchasing

Information Sources

Based on these areas, the system analyst works on the combinations of input, storage, processing, communication and generates the output in terms of various conceptual system designs. Different conceptual designs are developed and then compared in order to select the optimum design. The selected design should meet the requirements of the users as well as the organization and must be cost-effective.

The development of various conceptual designs can be evaluated on the basis of the following criteria:

- ***Economic basis:*** Each alternative based on this criterion provides benefits in terms of cost analysis.
- ***Performance basis:*** Each alternative must be evaluated for the anticipated performance, in accordance to the system objectives.
- ***Operational basis:*** Each alternative must determine the strong and weak points in terms of the quality of the databases, the information and the potential breakdown points.

7. Conceptual design documentation

After the selection of the final conceptual design, the design is documented in specific terms. The documentation of the conceptual design involves:

1. Overall system flow
2. System inputs
3. System outputs
4. Other documentations such as, activity sheet and system description.

8. Preparation of report

The next step to the documentation of the conceptual design is to get an approval from the management of the organization. Once an approval is given to the prepared document, a detailed design activity can be introduced. A proposal which involves the cost incurred and the probable organizational changes, is prepared in this stage. The report prepared in this stage should contain the following specifications:

1. A brief statement of the problem
2. A brief statement of the objectives
3. An overall view of the system
4. A simple justification for selecting a particular design among different designs
5. Other resources, such as, the time required for developing and implementing the system

The top management of the organization then reviews the submitted report. If the submitted report is approved, a detailed system design activity can be undertaken.

4.5 PLANNING AND IMPLEMENTATION OF MIS

Steps to implement MIS are:

- Planning for implementation
- Acquisition of facilities and space planning
- Developing MIS procedures
- User training
- Acquisition of hardware and software

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- Creating forms and database
- Testing
- Change over

Planning for Implementation

Planning involves identifying various actions such as determining the sequence of activities and estimating the time needed for each activity required to implement MIS. All these activities vary according to the design specifications of MIS, such as input, output, equipment and processing. Various tools can be used for planning, these include Gantt Charts and Network Diagrams.

Figure 4.12 shows a Gantt Chart.

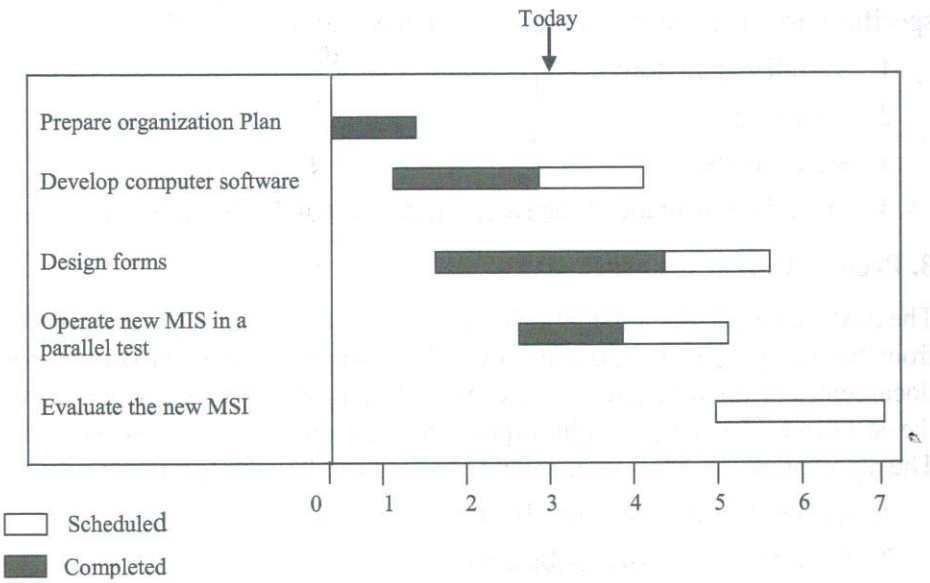

Fig. 4.12 A Gantt Chart

A Gantt chart contains horizontal bars displaying a time line on which activities are shown. The chart displays various interdependent jobs such that jobs that are done in parallel or jobs that are done in a sequence are highlighted. For example, Figure 5.4 shows a chart for developing a new MIS, in which five main activities are shown. Here, one can visualize that while the preparation of the organization plan finishes, the task of developing the computer software continues.

In this chart, the scheduled time for the tasks has been displayed by an empty bar and the actual time of completion is denoted by filling the area in the blank bar. The chart aids in assessing whether a particular task has been completed within schedule and how far is the target date of completion. The chart shows a schedule of approximately seven weeks.

A network diagram is prepared when a project contains many tasks, each task composed of several subtasks. For a simple project like this, a Gantt chart is adequate for planning the implementation.

Acquisition of Facilities and Space Planning

To implement MIS at the user's workstation, various facilities such as a computer room and a computer library are required. Therefore, the MIS manager also needs to do space planning. Space planning includes estimating the space occupied by computers and its various peripherals such as terminals, printers and workers. The MIS manager also needs to decide the location of the computer room and its safety and security factors.

Since MIS handles vital information related to the working of the organization that involves a collection of information, networking may be required to facilitate an easy transfer of information. If different departments of the organization are located at different areas of the same place, a local area network is sufficient. This requires the MIS manager to coordinate with the system developers. The records related to the functioning of MIS should be secured in an area where access is restricted. Due to space constraints the cost of space these days is quite high thus, an economy of space utilization is vital. Multi utility desks, shelves, etc, should be used to allow an economical space utilization for storing records, stationery and storage devices such as floppy disks, CD-ROM and external disks.

Organization and Procedure Development

The MIS manager starts recruiting other required human resources for the MIS. The MIS manager also starts developing procedures for various other activities such as evaluating as well as selecting hardware as well as buying or developing the required software.

Depending on the nature of organizational activities, the MIS manager develops formats required to manage the information system according to which the software is developed. Since received information has to be sent to the management for its review and subsequent decision-making process in a report form, only that information which is relevant to the higher management should be provided. These reports should be timely and accurate.

In a big organization, different types of reports are prepared requiring suitable personnel. The MIS manager has to organize the human resources available for such purpose to work on data required to create such reports using a computer-based information system. Acquisition of suitable software and hardware is required for this purpose, keeping in view the upcoming needs of the organization. It is always advisable to acquire a system that supports *scalability*. This means that when the workload increases and the system is required to handle a large volume of data, of a somewhat different nature, it should be able to do it without any additional investment in system upgradation or the services of an expert. For example, a hardware should be able to support a more advanced system software. At present Windows XP is used in most organizations and it requires a minimum of 256 MB of RAM, but runs better on a system having a 512 MB of RAM. But it will be wise to take 1 GB of RAM or a system in which another 512 MB RAM can be added to accommodate an improved version of the operating system that supports an advanced application software. Now Windows 7 has entered the market that requires 1 GB of RAM. Thus, making a system adaptable to an

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advanced software enhances the installed system which facilitates in the development of a more efficient procedure without replacing the hardware.

User Training

For successfully implementing MIS, the MIS manager must organize trainings for the users according to their requirement. For example, training for clerical users must include the processing and functioning of MIS. A manager must also be informed about the procedure for online inquiries.

Once the system is installed and put to use, the users should be conversant with its use. When a new system is installed or an old system is replaced with the new system, users need suitable training about the system. This requires a proper training to enable users to work efficiently on the system. Most developers provide manuals and other documentations for this purpose, but it is not possible for everyone to learn these by merely going through these documents and such an approach is not practical. Thus, training is essential and the system developer should be entrusted with the task of training customers after installation. The MIS manager with the help of a system developer should organize the training for an efficient handling of the MIS system. The main aspects of user training are:

- Imparting knowledge on the execution of the package
- The method of data entry
- Processing of data to take out reports in the prescribed format

Acquisition of Hardware and Software

Immediately after deciding the MIS design specifications, the process of purchasing or developing the required hardware and software starts. Selecting hardware and software is discussed later in this unit.

The MIS manager should ensure that the essential prerequisites such as computer room, electric connections and communication lines, required to install the hardware are fulfilled. The MIS manager should also ensure that other consumables, such as papers and floppies are available as required.

While acquiring hardware and software, the recommendations of the system developers should be kept in mind. More vendors should be invited to submit their bids to get a competitive price. A general idea of products offered by different vendors and manufacturers should be acquired. The quality of hardware should not be compromised in order to acquire low prices. While inviting bids, a list of installations made for users by the supplier/manufacturer should be demanded, and an internal enquiry regarding these listed users should be made. There are many new entrants in the market and their products may yet not be established. It is always advisable to avoid such entrants even if they offer products at cheaper rates.

Creation of Forms and Database

The database is used to store data, and forms are used for transmitting data. Forms are used to input data to MIS and receive the output data from the MIS. Therefore, the implementation of MIS also requires forms and databases. The database and forms are generated in context of the entire MIS.

Different formats needed for MIS should be created and carefully reviewed and a suitable database for this should be made, suited to the requirement of the MIS used by the organization. Developers recommend the use of a relational database package. There are many such relational database packages. Such relational databases can be used for a variety of purposes. A company database should be created according to the need of the organization on any of these software packages, for efficient retrieval of information, based on queries needed for creating reports in suitable formats. Forms should be designed such that they can be opened online when needed and sent directly. Such online forms ensure secrecy of vital business-related information. This also reduces the need for papers.

Testing

Testing is a process that is performed to evaluate whether or not each element of MIS such as equipment, programs and forms, works according to the design specifications. Testing also calculates accuracy, range of inputs, frequency of inputs, operating conditions and reliability factors of the MIS.

Nowadays, a Computer Aided Software Engineering (CASE) tool is used to perform testing of MIS.

Developers of the system after successful testing get ready for the acceptance test by the end-user. Thus testing is conducted at the customer's premises to show that the system developed is capable of performing well as desired by the customer. Developers should display the workability of the system and the end-users have the responsibility to check whether the system installed meets the needs or not. Normally, demonstrations on the working of the system and training of personnel who will handle the system are in tandem.

The system must be evaluated by testing after implementation. Evaluation is essential for the following reasons:

- Evaluating the accessibility of the system
- Analysing the limitations of the system
- Further enhancements of the system

Testing and evaluations are of four types:

(i) Operational evaluations; to check for proper operation
(ii) Evaluation for organizational impact; to see how it improves the working
(iii) User's assessment about the product
(iv) Development of performance based on existing practice and future needs

This is the last opportunity that the customer gets for removal of bugs, if any, that may be found in the system.

Changeover

After performing the testing, the last step is to put the MIS at the user's workstation. The process of placing the newly developed MIS at the workstation differs depending on the following two situations:

- Placing only the new MIS system
- Replacing an existing MIS system by the new one

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If an MIS system is not available at the user's workstation, then you can directly install MIS.

However, if an MIS system is available at the user's workstation, then there are four policies to replace the existing MIS system with the new one:

- **Direct:** Uninstall or remove the existing MIS and install the newly developed MIS in place of the old one. This policy is used when the existing MIS is absolutely worthless.
- **Parallel:** Install the newly developed MIS parallel to the existing MIS, until the new MIS is tested properly. In this policy, output from both the existing and the new MIS are compared and tested. If the new MIS gives the desired output then the previously installed MIS can be removed.
- **Modular:** Install the new MIS at the user's workstation on a module basis. In this policy, the user's workstation is divided into groups and the new MIS is installed for each group.
- **Phase-in:** Is similar to the modular policy. However, in this policy the new MIS is segmented, instead of the user's workstation. In this policy, each MIS segment is installed at the user's workstation and performs a specific function.

Check Your Progress

6. What are the objectives of system design?
7. What are the types of abstractions in system design?
8. How can you classify system constraints?
9. State about the forms and database in MIS.

4.6 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Al Gore, former US Vice President.
2. A host is a computer that has data to transmit. It is at one end of the transmission system.
3. System analysis is a process in which data is collected and then interpreted to identify problems within the system. After interpretation, problems are identified. Therefore, the collected information can then be used to recommend improvements in a system. In other words, system analysis includes identifying, understanding and examining a system so that the objectives of the system can be achieved.
4. It is essential to determine the requirements of a system for the system analysis process. The requirement determination is the preliminary step of the system development activity and is also known as software requirement specification (SRS).

5. A data dictionary is a structured repository of data that defines the basic organization of a database. The data dictionary contains a set of precise and accurate definitions of all the DFDs, data elements and data structures.
6. The objectives of the system design are: Practicality, flexibility, integrity, reliability and efficiency.
7. The abstractions in system designs at the lower level are: Procedural abstraction, data abstraction and control abstraction.
8. System constraints may be classified into external constraints and internal constraints.
9. The database is used to store data, and forms are used for transmitting data. Forms are used to input data to MIS and receive the output data from the MIS. Therefore, the implementation of MIS also requires forms and databases. The database and forms are generated in context of the entire MIS.

4.7 SUMMARY

- Information superhighway was a popular term used through the 1990s to refer to digital communication systems.
- Telecommunication is the communication of information by electronic means, usually over some distance.
- A telecommunications system is a collection of compatible hardware and software arranged to communicate information from one location to another. A network system consists of hardware components as well as software components.
- A host is a computer that has data to transmit. It is at one end of the transmission system.
- System analysis is a process in which data is collected and then interpreted to identify problems within the system. After interpretation, problems are identified. Therefore, the collected information can then be used to recommend improvements in a system. In other words, system analysis includes identifying, understanding and examining a system so that the objectives of the system can be achieved.
- System analysis is really vital in the completion of the development process of a system. It may be possible that a user is aware of the problem but may not have the solution.
- Requirement analysis is a formal process of interacting with a client to understand and establish the requirements of the client in a formal document.
- It is essential to determine the requirements of a system for the system analysis process. The requirement determination is the preliminary step of the system development activity and is also known as software requirement specification (SRS).

- The interview strategy follows a method in which a user and a developer interact with each other to collect the required data. In this method, the developer poses questions to the user and based on the response given by the user, the developer finds some solutions.
- The record review strategy is also known as review of documentation strategy. The main purpose of this strategy is to find the quantitative information regarding constraints such as volumes, frequencies and ratios.
- A data dictionary is a structured repository of data that defines the basic organization of a database. The data dictionary contains a set of precise and accurate definitions of all the DFDs, data elements and data structures.
- System design is an important step in the system development process. This phase comes into existence after the system analysis is completed. This means the output of the system analysis phase provides an input to the system design phase.
- The objectives of the system design are: Practicality, flexibility, integrity, reliability and efficiency.
- The abstractions in system designs at the lower level are: Procedural abstraction, data abstraction and control abstraction.
- System constraints may be classified into external constraints and internal constraints.
- In order to ensure smooth implementation of MIS, certain steps are planning for implementation, acquisition of facilities and space planning, developing MIS procedures, user training, acquisition of hardware and software, creating forms and database, testing, changeover.

4.8 KEY TERMS

- **Telecommunication:** It is the communication of information by electronic means, usually over some distance.
- **Telecommunication system:** It is a collection of compatible hardware and software arranged to communicate information from one location to another.
- **Requirement analysis:** A formal process of interacting with a client to understand and establish a formal document of his requirement.
- **System Requirements Specification (SRS):** A formal document that is created to capture the requirements of the system.
- **Data Flow Diagram (DFD):** A powerful tool to understand the functional and informational views of a system.
- **Data Dictionary (DD):** A structured repository of data that defines the basic organization of a database.
- **Abstraction:** The conceptualization of an issue or problem or entity in terms of some level of generalization disregarding irrelevant low-level detail.

- **Refinement:** A top-down design strategy in which the design is refined after successive steps.
- **Modularity:** A concept which aids the designer to compartmentalize the design into functional compartments as the entire system can be conceived to be composed of a set of modules, each having its own special feature and functionality.
- **Procedural abstraction:** A named collection of several sequential procedural steps when abstraction is used to define procedural issues.

4.9 SELF-ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Name and briefly describe the components of a telecommunication system.
2. Define requirement analysis.
3. List the various structured analysis tools.
4. What is a data flow diagram?
5. Write the principles of design.
6. State about the abstraction.
7. What is user training?

Long-Answer Questions

1. Why has telecommunication technology become such an important issue for managers and organizations?
2. What is a telecommunication system? Explain the principal functions and components of all telecommunication systems.
3. Briefly explain the principles of analysis.
4. Explain the various strategies for requirement determination.
5. Describe the data items required in a data dictionary with the help of appropriate examples.
6. Discuss the stages in development of designs.
7. Briefly explain the various steps to implement MIS giving appropriate examples.

4.10 FURTHER READING

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UNIT 5 DATABASE MANAGEMENT AND TYPICAL INFORMATION SYSTEMS

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Structure

5.0 Introduction
5.1 Objectives
5.2 Introduction to File Processing and DBMS
5.3 Typical Information Systems
5.4 Answers to 'Check Your Progress'
5.5 Summary
5.6 Key Terms
5.7 Self-Assessment Questions and Exercises
5.8 Further Reading

5.0 INTRODUCTION

A database is an organized collection of data stored and accessed electronically from a computer system. Where databases are more complex they are often developed using formal design and modeling techniques. The database management system (DBMS) is the software that interacts with end users, applications, and the database itself to capture and analyze the data. The DBMS software additionally encompasses the core facilities provided to administer the database. The sum total of the database, the DBMS and the associated applications can be referred to as a 'database system'. Often the term 'database' is also used loosely to refer to any of the DBMS, the database system or an application associated with the database.

Business organizations, non-profit organizations and individuals depend on information systems to manage their day-to-day functions, get competitive advantage, supply as well as receive services and lead comfortable lives. For example, modern business firms depend on information systems to process their accounts and manage human resources; local governments use information systems to provide basic services to its citizens; individuals rely on information systems for studying, shopping, banking and investing purposes.

In this unit, you will study about the introduction of file processing and DBMS, typical information system.

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5.1 OBJECTIVES

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

- Understand the introduction of file processing and DBMS
- Explain the typical information system

5.2 INTRODUCTION TO FILE PROCESSING AND DBMS

Many firms require Online Transaction Processing (OLTP), which means the transactions entered online are processed immediately and the database is updated. However, network failure, heavy network traffic, low server resources, etc., can lower or disrupt the performance of the system. This can cause huge losses to business firms, and thus, firms employ many methods to ensure that the systems are operational during critical situations and the applications are always available. Some of the methods are as follows:

- Fault-tolerant systems contain multiple hardware, software and power supply components so that in case any one of them goes down, the other component takes over. A fault-tolerant system has extra memory chips, processors, and storage devices, and it uses software routines to detect any hardware failure, and automatically switches to the backup device.
- High-availability computing provides system availability by speedy recovery in case of a system crash.
- Load balancing is done to distribute large numbers of access request to multiple servers so that no single server is flooded with all the requests.
- Mirroring is done to duplicate all the processes and transactions of a primary server on a backup server. In case of failure of primary server, the backup server takes over immediately so that there is no interruption in providing service.

Why are Systems Vulnerable?

Today, most organizations use Web-based information systems, which typically include a Web client, a server, and a database linked together through communication lines. Each of these components is vulnerable to different types of threats (see Figure 5.1). The client systems, for example, are vulnerable to computer viruses, user errors and unauthorized access. Similarly, communication lines are vulnerable to tapping and sniffing, database is vulnerable to data theft and alteration, and so on.

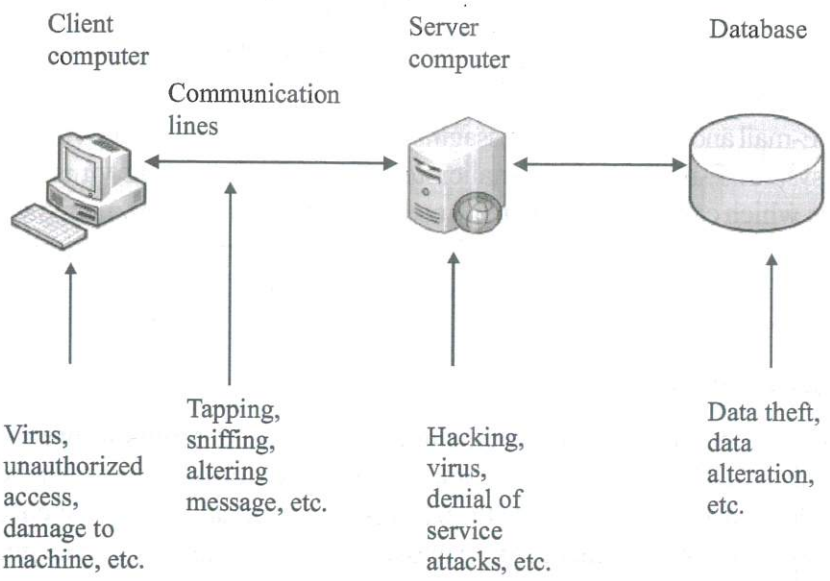

***Fig. 5.1** Vulnerabilities of Various Systems*

Note that any natural calamity, power failure, and other electrical problems can cause disruptions at any point in the network. These threats can be the result of technical, organizational, or environmental factors. These factors can increase the potential of threats if management decisions are poor.

Systems are also vulnerable to attack by an employee of the organization who has grudges with the management or the organization. This employee can tap important information of the organization with much more ease than an outsider and can sell it to some rival company.

Outsourcing of application development to other organizations increases system vulnerability. Programmers developing the applications might include some code in the applications which later enable someone to gain unauthorized access to the application or its data.

Internet Vulnerabilities

Private network of organizations may have connection to public network, such as the Internet. In such situations, the information systems of organizations become more vulnerable to attack because anyone connected to the Internet can illegally access the confidential information. Since the Internet is a very big network, the sources of the threats are spread virtually over the entire world.

Organizations may connect their network to the Internet by dial-up connection or by cable modems or Digital Subscriber Lines (DSL). In case of dial-up connections, a temporary IP address is assigned to computers for each session. On the other hand, computers constantly connected to the Internet through cable modems or DSL have fixed IP addresses. The fixed IP addresses make the computers more prone to damage, since the targets for hackers are fixed.

Data in non-encrypted form is more vulnerable if it travels over insecure public network. Most of the voice data over the Internet, for example, is not

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encrypted, which makes it more vulnerable. Anyone linked to the network can listen to the conversations and can take away the confidential personal information, such as credit card numbers.

E-mail and other instant messaging services have increased the vulnerability of the system. E-mails can have malicious software program (like virus) attached to them which can install itself on the user computer. This program might enable the person who sent the mail to read the personal information. Employees may also send companies' secrets to unauthorized users via an e-mail message or attachment.

Internet Hackers

Hackers are people who focus on finding some weak points in the security mechanism of Websites and other computer systems in order to gain unauthorized access. In the hacking community, the hackers with criminal intent are often termed as crackers; but in mass media these two terms are often used interchangeably.

The activities of hackers are not limited to only gaining unauthorized access to systems, but also include theft of confidential information and damage to the information systems. They can also introduce viruses in the network which can enter database or other applications and crash the whole server.

Spoofing and Sniffing

Hackers often spoof by hiding their identity and pretending themselves to be someone else by using fake addresses. Hackers can divert a Web link to some other address that is of the hackers' interest. A link directed to a duplicate e-commerce Website created by a hacker, for example, can help him in collecting and processing orders, stealing sensitive customer information, and so on.

Sniffer programs are used to listen to data travelling in the network without permission of the sender of the data. These programs, if used in the right way, can help in finding network trouble spots or criminal activities on the network. Sniffer can also be used for criminal activities like extracting e-mail messages, files and confidential reports.

Denial of Service (DoS) Attack

Hackers mischievously flood a network server or a Web server with many false requests for services in order to crash the network. In this situation, the server is not able to serve the genuine requests. This attack is known as Denial of Service (DoS) attack. A variant of DoS attack is Distributed Denial of Service (DDoS) attack in which numerous computers are used to generate false requests for a network. Using numerous computers help the hacker to flood the network with false requests very quickly.

Note that DoS attack does not damage information or access the restricted areas, but can shut down a Website, thereby making the site inaccessible for genuine users. Such kinds of attacks result in a huge loss of business if used on busy e-commerce sites, such as eBay and Buy.com, because the customers cannot make purchases while the site is shut down.

Data Hierarchy

In computer systems, data is organized in a hierarchy where bit is at the lowest level and database is at the highest level (see Figure 5.2). All the terms in the increasing order of hierarchy are as follows:

- **Bit:** The smallest unit of data that can hold only one of the two values, 0 or 1, is known as bit.
- **Byte:** A group of 8 bits is known as a byte. It indicates a single character that can be a number, an alphabet, or any other symbol.
- **Field:** A set of characters that together form a word is known as a field. A grouping of alphabets, for example, may form a name field and the grouping of numbers may form a salary field.
- **Record:** A group of related fields that can be treated as a unit form a record. Fields such as employee number, name, address, department number, and salary for a particular employee form a record.
- **File:** A collection of logically related records is called a file.
- **Database:** A group of logically related files is called database. It combines the records from several distinct files into a centralized location from where many applications can retrieve the data.

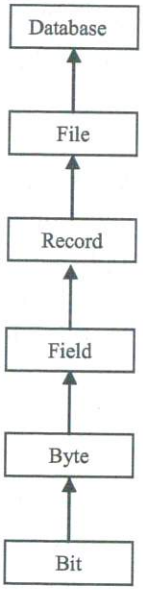

Fig. 5.2 The Data Hierarchy

The File Processing Approach

Earlier, the file processing approach was used across organizations for business data processing where data was stored in independent files, and a number of application programs were required to be written by the programmers to manipulate the files. Each functional area, such as finance, marketing and human resources, used to maintain their own set of data files and application programs. Thus, the data of the organization was dispersed throughout different functional areas.

The file processing approach was adequate until the development of enterprise-wide applications which required the coordination and integration of data from key business processes. Besides, this approach has some other disadvantages, which are as follows:

- **Data Redundancy and Inconsistency:** Same information may be duplicated in several files. The name and address of an employee, for example, may appear in a file consisting of details of employees as well as in files consisting of details of working hours of employees. This duplication of data is known as *data redundancy*, which leads to wastage of storage space. The other problem with file processing approach is that the data may not be updated consistently. Suppose the address of an employee changes, then both the files containing the address of that employee must be updated. This is because if the address is not modified in any of the two files, then the same employee will have different address in different files. This is known as *data inconsistency*.
- **Integrity Problems:** In any application, there are certain data integrity rules that need to be maintained. These rules could be in the form of certain conditions or constraints. The integrity rule that each employee, for example, should have an employee number has to be implemented in all those application programs that need to access the file containing the employee number. In a file processing system, all these rules need to be explicitly programmed in all the application programs. In addition, when new constraints are to be enforced, all the application programs should be changed accordingly.
- **Lack of Insulation Between Program and Data:** The file processing system lacks insulation between program and data. This is because the file structure is embedded in the application program itself; thus, it is difficult to change the structure of a file as it requires changing all the application programs accessing it. Suppose, the data type of the field employee number is changed from string to number, changes have to be made in all the application programs that are accessing the file containing the employee number.
- **Difficulty in Accessing Data:** Suppose a need arises to print the details of all the employees working on a particular project. One way to handle this request is to use the existing application program that prints the details of all employees according to their projects, and then manually generate the list of employees working on a particular project. Obviously, it is unacceptable. Alternatively, the programmer is requested to write a new application program. Now, if after sometime, suppose that another request arises to filter the list of employees working on a particular project and having salary less than ₹ 10,000. Then again we have to write a new application program.
- **Poor Security:** The application programs are added in an unplanned manner, the detail of each file is easily available to every user. Thus, the file processing system lacks the security feature.

The Database Approach

The bottlenecks of the file system approach lead to the introduction of the database approach, which consolidates data from distinct files into databases that can be shared by a number of applications. A database can be defined as a collection of interrelated data from which users can efficiently retrieve the desired data.

In addition to the storage and retrieval of data, certain other operations can also be performed on a database. These operations include adding, updating and deleting data. All these operations on a database are performed using a Database Management System (DBMS), which is an integrated set of programs used to create and maintain a database. The main objective of DBMS is to provide a convenient and an effective method to define, manipulate, store, and retrieve the data stored in the database. In addition, DBMS ensures the security of the database from unauthorized access, and the recovery of data during system failures. It also provides techniques for data sharing among several users. The database and the DBMS software are collectively known as the database system.

Advantages of the Database System

In the database approach, the data is stored at a central location and shared among multiple users. Thus, the main advantage of the database system is the centralized data management. The centralized nature of the database system provides several advantages which overcome the limitations of the conventional file processing approach. These advantages are as follows:

- **Controlled Data Redundancy:** During the database design, various files are integrated, and each logical data item is stored at a central location. This eliminates replication of the data item in different files, and ensures consistency and saves the storage space. Note that the redundancy in the database systems cannot be eliminated completely, as there could be some performance and technical reasons for having some amount of redundancy. However, DBMS should be capable of controlling this redundancy in order to avoid data inconsistencies.
- **Enforcing Data Integrity:** In the database approach, enforcing data integrity is much easier. Various integrity constraints are identified by the database designer during designing the database, some of which are enforced automatically by DBMS while others are to be implemented in the application programs.
- **Data Sharing:** The data can be shared among the various application programs. Moreover, new applications can be developed to use the same stored data. Data sharing enables to satisfy the data requirements of new applications without having to create any additional data or with minimal modification.
- **Ease of Application Development:** The application programmer needs to develop the application programs according to the needs of the users. The other issues like concurrent access, security and data integrity are handled by DBMS. This makes the application development an easier task.

- **Data Security:** Since the data is stored centrally, enforcing security constraints is much easier. DBMS ensures that the only means of access to the database is through an authorized channel. Hence, data security checks can be carried out whenever access is attempted to sensitive data. To ensure security, DBMS provides security tools, such as user codes and passwords.
- **Multiple User Interfaces:** To satisfy the demands of various users having different technical knowledge, DBMS provides different types of interfaces, such as query languages, application program interfaces, and Graphical User Interfaces (GUI) that include forms-style and menu-driven interfaces. A form-style interface displays a form to each user and the user interacts using these forms. In a menu-driven interface, the user interaction is through the lists of options known as menus.
- **Backup and Recovery:** DBMS provides backup and a recovery subsystem which is responsible for recovery from hardware and software failures. If, for example, the failure occurs in between the transaction, the DBMS recovery subsystem either reverts the database back to the state which existed prior to the start of the transaction or resumes the transaction from the point it was interrupted, so that its complete effect can be recorded in the database.

In addition to the advantages due to the centralized data management, database system also has some other advantages, which are as follows:

- **Program-Data Independence:** It is an important characteristic of DBMS that allows changing the structure of the database without making any changes in the application programs which are using the database.
- **Data Abstraction:** The property of DBMS that allows program-data independence is known as data abstraction. Data abstraction allows the database system to provide its users with an abstract view of data without providing the physical storage and implementation details.

Components of DBMS

A database management system has the following three components:

1. **Data Definition Language (DDL):** The data definition language is a special language that allows specifying the structure of the database. The DDL statements are also used to specify the integrity rules, thereby maintaining the database integrity. Like any other programming language, DDL also accepts a set of instructions (statements) as input and generates the description of structure of the database as output.
2. **Data Manipulation Language (DML):** Once the database structure is defined, data needs to be manipulated. The manipulation of data includes insertion, deletion, and modification of records. DBMS provides a Data Manipulation Language (DML) that enables users to retrieve and manipulate the data. The statement which is used to retrieve the data is called a query.
3. **Data Dictionary:** Apart from the data, the database also stores *metadata*, which describes the tables, columns, indexes, constraints, and other items that make up the database. In simple words, metadata is data about data. This metadata is stored in an area called the data dictionary. DBMS refers

the data dictionary before reading or modifying the data. Note that the database users cannot update the data dictionary; instead it is only modified by the database system.

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People who Work with Databases

Database is an important asset of business. To design, use and maintain such important asset, many people are involved. The people who work with databases include the *database users, systems analysts, application programmers*, and the *Database Administrator (DBA)*. Database users are those who interact with the database in order to query and update the database, and generate reports. Database users are further classified into the following categories:

- **Naive Users:** The users who query and update the database by invoking some already written application programs. The naive users interact with the database using form interface.
- **Sophisticated Users:** Users, such as business analysts and scientists who are familiar with the facilities provided by DBMS interact with the system without writing any application programs. Such users use the database query language to retrieve data from the database to meet their complicated requirements.
- **Specialized Users:** The users who write specialized database programs which are different from traditional data processing applications, such as banking and payroll management which use simple data types. Specialized users write applications, such as expert systems, knowledge-based systems, and CAD systems that store data having complex data types.

Systems analysts determine the requirements of the database users (especially naive users) to create a solution for their business needs, and focus on non-technical and technical aspects. The non-technical aspects involve defining the system requirements, facilitating interaction between the business users and technical staff. The technical aspects involve developing the specification for user interface. *Application programmers* are the computer professionals who implement the specifications given by the systems analysts, and develop application programs. They can choose tools, such as Rapid Application Development (RAD), to develop the application programs with minimal effort. The database application programmer develops application programs to facilitate easier data access for the database users.

The Database Administrator (DBA) is a person who has central control over both the data and the application programs. The responsibilities of a DBA vary depending on the job description, and the corporate and organizational policies. Some of the responsibilities of a DBA are as follows:

- **Schema Definition and Modification:** The overall structure of the database is known as the database schema. It is the responsibility of the DBA to create the database schema by executing a set of data definition statements in DDL. The DBA also carries out the changes to the schema according to the changing needs of the organization.
- **New Software Installation:** It is the responsibility of the DBA to install new DBMS software, application software, and other related software. After installation, the DBA must test the new software.

- **Security Enforcement and Administration:** The DBA is responsible for establishing and monitoring the security of the database system. It involves adding and removing the users, auditing, and checking for the security problems.
- **Data Analysis:** The DBA is responsible for analysing the data stored in the database, and studying its performance and efficiency in order to effectively use the indexes, parallel query execution, etc.
- **Preliminary Database Design:** The DBA works along with the development team during the database design stage due to which many potential problems that can arise later (after installation) can be avoided.
- **Physical Organization Modification:** The DBA is responsible for carrying out the modifications in the physical organization of the database for better performance.
- **Routine Maintenance Checks:** The DBA is responsible for taking the database backup periodically in order to recover from any hardware or software failure (if they occurs). Other routine maintenance checks that are carried out by the DBA are checking the data storage and ensuring the availability of free disk space for normal operations, upgrading disk space as and when required.

DBMS Architecture

A major purpose of DBMS is to provide users with an abstract view of the database. It implies that the system does not provide all the details of data; rather it hides the details of how the data is stored and maintained. DBMS provides three levels of abstraction, namely *internal, conceptual* and the *external level.*

(i) **The Internal Level:** This is the lowest level of data abstraction that deals with the physical representation of the database on the storage medium. The internal level is also known as the physical level. At this level, complex low-level data structures are described in detail which deal with the actual storage. The data structure simply includes what data is stored and how it is represented in the memory. The low-level data structure also includes the internal details of the database, such as the storage space occupied by a record and the offset for each data of a record.

(ii) **The Conceptual Level:** This level describes what type of data is actually contained in the database and what relationships exist among them. The conceptual level is also known as the *logical level.* At this level, the database is described in the form of simple structures, such as tables and constraints. The users of the conceptual level are not concerned with the details of the internal level. They are just concerned with 'what' data is contained rather than 'how' it is contained.

(iii) **The External Level:** This is the highest level of abstraction. The external level (or the view level) depicts the view of the database from an individual user. Most users of the database do not require all the information contained in the database. Hence, the database can provide different information to

different classes of users. Concisely, this level is concerned with the way in which individual users view the data.

Figure 5.3 shows the DBMS architecture (also known as the three-level architecture) for the employee database containing details like employee number, employee name, salary, and so on. The external level shows the database view from two different users. The first user's external view incorporates two fields, Employee Number and Employee Name. The second user's external view also incorporates two fields, namely Employee Name and Salary. The conceptual level represents different fields of database like Employee Number (6 characters), Employee Name (25 characters) and Salary (5 digits). The internal level represents the total record length (36 bytes) of the database. Note that an offset is the displacement of the data from the base address in the memory.

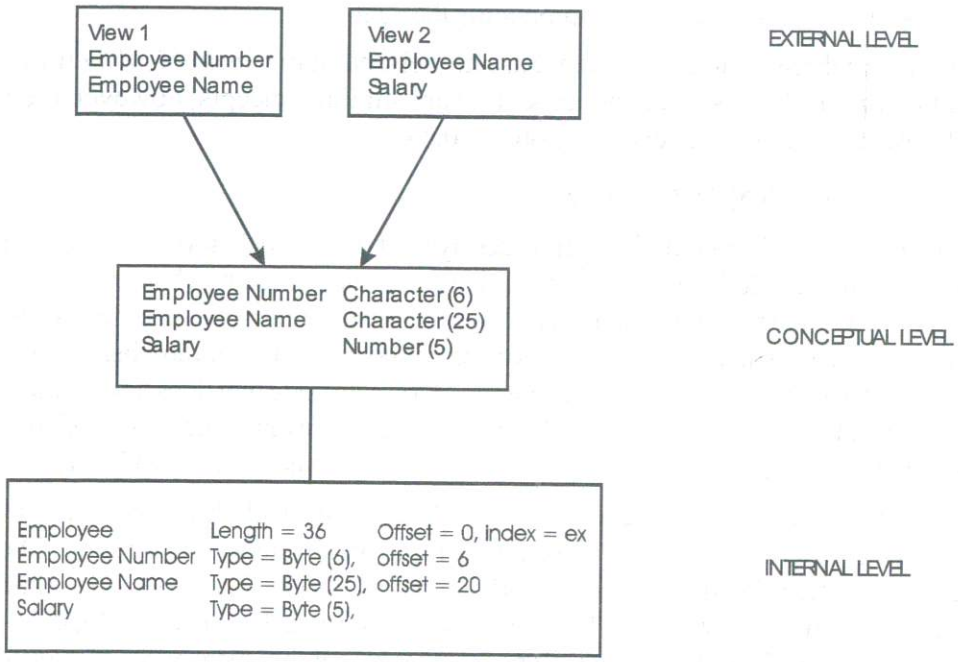

***Fig. 5.3** The DBMS Architecture*

Data Independence

The main advantage of the three-schema architecture is that it provides data independence. Data independence refers to the ability to modify the database structure at one level without affecting the database structure in the next higher level. There exist two levels of data independence, namely *logical data independence* and *physical data independence.*

- ***Logical Data Independence:*** It is the ability to make changes of the external views or application programs at the conceptual level independently. Simply, it pertains to the immunity of the external model to the modifications in the conceptual model. The examples of the changes at the logical level include addition and removal of entities in the database.
- ***Physical Data Independence:*** It is the ability to change the physical organization of data without making any changes at the conceptual or external level. Modification at the physical level is occasionally necessary in order to

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improve the performance. Simply, it pertains to immunity of an application to the modifications in the internal level and the access strategy (the way of accessing data). The examples of changes at the physical level include reorganization of files, adding a new access path, etc.

Data Models

As discussed earlier, the conceptual level describes what type of data is actually contained in the database and what relationships exist among them. However, how and what data structures are required to represent the data and their relationships depend on the data model being used. The term data model refers to organizing and representing a detailed database in different ways. A data model consists of the following two parts:

- A mathematical notation to depict the data and the relationships.
- A set of operations for manipulating the data.

There are three basic types of database models, namely *hierarchical, network and relational*. These database models share similar concepts; however, their differences result from how they store the data.

The Hierarchical Data Model

The Hierarchical Data Model is the oldest type of data model, developed by IBM in 1968. In this Model, data is organized in a tree-like structure where each child node (also known as dependents) can have only one parent node. In other words, a hierarchical database is a collection of records connected to one another through links. The top of the tree structure consists of a single node that does not have any parent and is called the root node. The root may have any number of dependents; each of these dependents may have any number of lower level dependents.

Consider, for example, an Employee database that includes the record types (collection of similar type of records)—Employee, Project and Duration. The Employee record type includes the fields Employee_Code, Employee_Name and Salary of an employee. The Project record type includes Project_Code and Project_Desc. The Duration record type includes No_of_hrs spent by the employee on a project. Every employee is assigned some projects.

Figure 5.4 represents the Hierarchical Model for the Employee database. One complete record of each record type represents a node. The node for an Employee record is linked to all those nodes of the Project record type that represent the projects on which that employee is working. In addition, each node of the Project record type is linked to a specific node of the Duration record type.

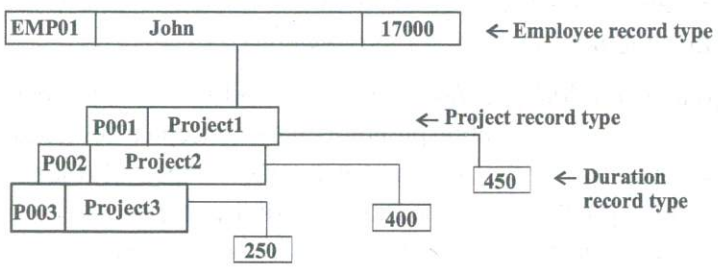

Fig. 5.4 The Hierarchical Data Model for the Employee Database

all the tables can be linked with each other using a common attribute in the tables. Such linking is called a relationship.

Figure 5.6 represents the Relational Model of the Employee database. In this figure, the Employee database includes three relations—Employee, Project and Duration. The Employee relation includes the attributes Employee_Code, Employee_Name and Salary. The Project relation includes the attributes Project_Code and Project_Desc. The Duration relation includes the attributes Employee_Code, Project_Code and No_of_hrs. Since an employee is assigned a project, the relations Employee and Project are linked with each other with the help of the relation Duration.

Employee Relation

Employee Code	Employee Name	Salary
EMP01	John	17000
EMP02	Smith	19000
EMP03	Clark	22000

Project Relation

Project Code	Project Desc
P001	Project1
P001	Project2
P001	Project3
P001	Project4

Duration Relation

Employee Code	Project Code	No of hrs
EMP01	P001	450
EMP01	P002	400
EMP01	P003	250
EMP04	P004	300

Fig. 5.6 *The Relational Data Model for the Employee Database*

Keys

Key is one of the important concepts of relational database. It can be *primary key, candidate key,* and *foreign key.*

Primary Key

An attribute that uniquely identifies each record in a relation is known as a primary key. This implies no two records in the relation can contain the same value for the primary key. In addition, the attribute chosen as the primary key cannot accept null value. In the Employee relation, for example, the attribute Employee code is the primary key because all employee codes are unique. Note that in any relation there can be only one primary key.

Candidate Keys

In a relation, there can be more than one attribute that can uniquely identify each record. All such attributes are known as candidate keys. Out of these candidate keys, one is chosen as a primary key while the others that are not chosen as the primary key are referred to as alternate keys. In the Employee relation, for example, there are two candidate keys, namely Employee code and Employee name (considering no two employees can have the same name). If the attribute Employee code is chosen as a primary key, the attribute Employee name becomes the alternate key.

Foreign Key

An attribute of a relation that references the primary key of another relation is referred to as the foreign key. Figure 5.7 illustrates the relationship of the foreign

key constraint to the primary key constraint. Here, the attribute Item_Code in the PURCHASE relation references the attribute Item_Code in the ITEM relation. Thus, the attribute Item_Code in the Purchase relation is the foreign key.

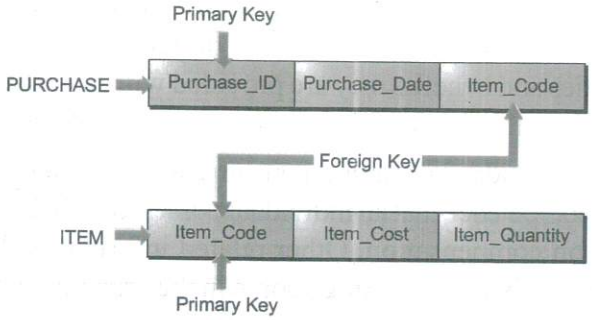

Fig. 5.7 The Foreign Key

Check Your Progress

1. What is the full form of OLTP?
2. What is spoofing?
3. What is a bit?
4. Name a few sophisticated users of database.
5. Who developed the Relational Data Model?

5.3 TYPICAL INFORMATION SYSTEMS

The most precious asset of an organization is its human resource. Managing it well leads to growth and prosperity and mismanagement results in losses. Human resource MIS (HRMIS) helps managers manage the HR of the organizations in a better manner. The HRMIS, sometimes called HRIS, is an integrated system consisting of the following subsystems:

- **Recruitment subsystem:** Recruitment is a regular activity in an organization and involves the selection of suitable people for suitable jobs. Recruitment activity tends to increase with the expansion of the organization. It is an ongoing process because people leave an organization for various reasons. Therefore, recruitment neutralizes the effect of attrition and ensures that sufficient staff is always present to handle the growth activities of the organization.

  The HRIS is connected to online job portals and through these job portals, it downloads and shortlists candidates for the suitable positions in the organization. This subsystem also helps in manpower planning and in managing bench. The HRIS gives detailed information about likely candidates and aids the recruitment process.

- **Training and development subsystem:** The HRIS helps the ongoing training and development activities in an organization by giving detailed information about the training needs of employees, training modules and

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content, etc. to help the HR department take training and development-related decision.

- **Compensation and benefits management subsystem:** Compensation management involves deciding employees' compensation and benefits to ensure that they are satisfied in terms of the remuneration they receive and the facilities and benefits they are provided with. Compensation-related decisions depend on issues such as performance and seniority.

  The HRIS provides information on current market rates for the types of skill and competence that an individual possesses to help managers take a decision on compensation. Other related information like pay parity, information of similar ranking people in the organization, the historical compensation structure of the organization, etc. are also available with the HRIS to help the HR department decide compensation packages.

- **Performance management subsystem:** Performance management is a controlling activity wherein weak performers are recommended for training and strong performers are appropriately rewarded.

  The HRIS maintains important measures of performance for each employee to rate his/her performance. Based on the rating, high performers are rewarded, and the poor performer are relieved. This type of information is very important for deciding the employees' career plan.

Functions of Information Systems

Functionally, management can be segregated into several compartments; each having specific specializations. Normally, management is a term loosely used to identify people within an organization who have the authority and capability to take decisions (mostly functional for the middle and junior level, but strategic for the top level). The following is a brief description of the various functions wherein information systems are useful.

1. Marketing function

Marketing is the activity of reaching out to customers, communicating the offerings of the organization to them, selling the product or service and ensuring their satisfaction. It is the activity through which an organization can keep its ears close to the pulse of the market.

It generally encompasses the following sub-activities:

- **Sales**: It is the activity of selling the products or services of a firm. It is one of the most important activities of marketing and employs a large number of employees within the marketing department. Normally, sales function deals with the management of the channels of sales, i.e. managing wholesalers, retailers, stockists, etc., to ensure that the product or service reaches the consumer. Some authors argue that selling is a push activity for marketing in the sense that selling normally involves a top-down approach. Sales department is the interface between the customer and the organization. One can conceptualize a sales department as lying at the boundary between the organization system and the environment of the customers.

- **Advertising**: It is the activity of highlighting the positive aspects of a product, service, brand or company in electronic or print medium to create need among consumers. Advertising is essentially a 'pull' activity. It creates a need among consumers and thereby increases the revenue of the organization. Sometimes, advertising can also be associated with creating an image for the organization or sending a message to the consumers. It is a tool in the hands of marketers to promote their products or services. However, advertising is not an exclusively targeted activity in the sense that the communication from the company to its consumers is not targeted at the specific segments of consumers but sent to all consumers in general. This 'carpet-bombing' kind of strategy is a drawback of advertising.
- **Publicity:** It is that activity, which also results in greater revenue for the company. It ensures that positive articles get published or broadcast so that consumers are convinced of the efficacy of a product or service. Normally, it is done in a way to show that the article or broadcast does not have any direct association with the company or the brand. For example, when a prominent nutrition specialist writes a positive article about a health drink saying that it reduces (say) cholesterol, people reading the article may rightly infer that this is the honest opinion of the nutritionist; however, the fact may be that the health drink company may have persuaded or induced the nutritionist to promote the company's health drink. Publicity is used to create awareness and build customer base.
- **Product management**: It is the activity of managing the entire life cycle of a product. It involves managing all activities associated with the product.
- **Customer relationship management**: It is the activity of fostering loyalty of the customer towards a brand or a product or a company. It encompasses activities, which result in greater understanding and knowledge of the customer. It is the activity, which enables a company to have a long-term view of customers rather than having a short-term view. The activity of CRM is based on the understanding of the customer as a person who has a long-term relationship with the organization rather than at the time of sale only.
- **Market research**: It is the activity of conducting research on the market for planning strategies or finding out whether the strategies of the company are bearing results. It involves a lot of sampling survey and is applied to all aspects of marketing activity like finding out if an advertisement campaign has been successful or whether a class of product will have a market, etc. This activity is more prone to mathematical and statistical treatment and involves a lot of customer interaction.
- **Pricing**: It is the activity of setting the price of a product or a service. It is normally a strategic decision as it is done with a view to beat competition.
- **Packaging**: It is the activity of creating suitable packages for consumers so that the consumer is able to buy the product or service in order to maximize/ optimize the profit of the organization.

2. Finance function

No organization can survive without managing its finances. It is responsible for the management of receivables and payables, capital expenditure, costing and budgeting, taxes, etc. In short, finance is the function which helps us measure the value of the organization in monetary terms using several accounting, costing and mathematical tools. Financial management includes:

- **Working capital management**: It is the activity of managing the working capital of an organization. Working capital is the capital required to run an organization on a regular basis. It is used to pay for salaries and materials. It is normally in the form of a short-term debt.
- **Receivables and payables management:** The receivables and payables of a company are managed in this activity. It results in the management of creditors and debtors and helps management to take suitable decisions. This is a very important activity of finance and is done with diligence.
- **Budgeting:** It is a strategic function of finance. It is the activity by which the quantum of money spent on each activity of the organization is set. This is a complex exercise and one which requires a strategic view of the organization for the future.
- **Capital expenditure management:** This is an important activity which takes care of the capital expenditure of the company and makes a plan for such investments. These investments are inevitably linked with the cost of capital.
- **Auditing:** It is the process of controlling finance systems. It gives us the variations between the planned and unplanned financial decisions. It also serves as a tool for taking care of malpractices in the firm by exposing frauds within the system. It also reveals any deviation from the general rules of finance as laid down by the company. These deviations, if analysed further and found serious enough, warrant attention by the top management which fixes responsibilities on people for such deviations and takes corrective actions.
- **Managing external borrowings:** It is also an important function these days as more and more companies are borrowing from outside the country. This is a specialized task involving management of foreign exchange, etc.

3. Operational function

Every organization has an objective for existence, an offering in the form of a product or a service. Without an offering, management of other activities is meaningless. Operations management is that function, which helps an organization manage the various activities related to the creation of a product or service. The various activities associated with the operations management are as follows:

- **Production management:** It is the activity of managing the production process of a firm. It involves planning of production and capacities, monitoring of the production process, etc. so that control can be exercised over the production process.

- **Maintenance management:** It is the activity of managing the maintenance of machines in a firm. Different companies have different maintenance policies.
- **Quality management:** This activity is considered very important in most manufacturing and services organizations. It is the activity that measures the final output of the finished product or service against the standard. Any deviation from the standard is considered an aberration and corrective measures are applied to rectify the same. Quality management itself has several dimensions. Statistical quality control is a form of quality management that takes a view of quality that is measurable. Total quality management is the all-encompassing improved view of quality management that considers quality as a comprehensive package of managerial initiatives aimed at improving the quality culture of the organization.
- **Project management:** It is that activity that helps in efficient management of projects. It focuses on managing projects with respect to time and resource management. Precise mathematical techniques are used in this activity to manage projects.
- **Inventory management:** It involves the management of the raw materials and finished goods inventory of the company. This is an important activity as a lot of monetary resources are tied up in these areas. In addition, any shortfall in the raw materials may trigger a cascading effect on production and hence this activity is closely monitored. Vendors who supply the raw materials are carefully chosen and nurtured so that they perform their tasks with a high degree of reliability. Also, the lead time of vendors is closely monitored and updated regularly to reflect the current status. A lot of mathematical models are used for managing this function.

4. Human resource function

This function includes the following activities:

- Recruitment
- Training and development
- Compensation and benefits management
- Performance management

Macro-Level Information Systems

The main functions of Macro-level information systems are as follows:

- Collection, documentation and analysis of data
- Dissemination of market information

Various organizations require timely and accurate market information to take decisions. The various techniques for dissemination of market information at the macro level are as follows:

- Radio
- Newspaper

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- Notice boards
- Telephone

The macro-level challenges to the use of information systems are as follows:

- **Changing world:** Information systems have brought in tremendous change in the cultural, social, economic as well as political facets of the society. These changes affect the information systems also.
- **Greater concern for relevance:** As the society is changing, the information systems must change. Convincing the traditional stakeholders about the relevance of information systems is essential. Information systems are changing in accordance with the needs of modern organizational and business issues such as profitability and sustainability. For example, modern information systems provide agricultural programs that adapt to the challenges of community and economic development, biotechnology, youth programs, and drug and alcohol abuse.
- **Greater need for determining impact:** To determine the impact of information systems, appropriate impact indicators should be identified. It is difficult to identify the impact indicators because of the following reasons:
  - o Scattered sources
  - o Time lag
- **Information explosion:** Knowledge has been rapidly changing and expanding owing to the modern information systems. E-learning, distance education and publishing on the Internet have caused a kind of information revolution.

Check Your Progress

6. Define the term advertising.
7. What is the function of HRIS?
8. What are the main functions of MIS?
9. Name the five macro-level challenges to the use of information systems.

5.4 ANSWERS TO 'CHECK YOUR PROGRESS'

1. Online transaction processing system.
2. Spoofing is the process by which a hacker hides his identity and poses as someone else.
3. Bit is the smallest unit of data that can hold only one of the two values, 0 or 1.
4. Users, such as business analysts and scientists who are familiar with the facilities provided by DBMS interact with the system without writing any application program.

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5. The relational data model was developed by E.F. Codd of IBM in 1970.
6. Advertising is the activity of highlighting the positive aspects of a product, service, brand or company in electronic or print medium to create need among consumers.
7. The function of human resource information systems is to download resumes from job portals and shortlist candidates for suitable positions in an organization.
8. The main functions of macro-level information systems are as follows:
   - Collection, documentation and analysis of data
   - Dissemination of market information
9. The macro level challenges to the use of information systems as follows:
   - Changing world
   - Greater concern for the relevance
   - Greater need for determining impact
   - Information explosion

5.5 SUMMARY

- Many firms require Online Transaction Processing (OLTP), which means the transactions entered online are processed immediately and the database is updated. However, network failure, heavy network traffic, low server resources, etc., can lower or disrupt the performance of the system. This can cause huge losses to business firms, and thus, firms employ many methods to ensure that the systems are operational during critical situations.
- Most organizations today use Web-based information systems, which include a Web client, a server and a database linked together through communication lines.
- Private network of organizations may have connection to the public network, like the Internet. In such situations, the information systems of organizations become more vulnerable to attack because anyone connected to the Internet can illegally access the confidential information. Since the Internet is a very big network, the sources of the threats are spread virtually over the entire world.
- Hackers are people who focus on finding some weak points in the security mechanism of Websites and other computer systems in order to gain unauthorized access. In the hacking community, the hackers with criminal intent are often termed as crackers; but in mass media these two terms are often used interchangeably.
- In computer systems, data is organized in a hierarchy where bit is at the lowest level and database is at the highest level.

- Earlier, the file processing approach was used across organizations for business data processing where data was stored in independent files, and a number of application programs were required to be written by the programmers to manipulate the files.
- The bottlenecks of the file system approach lead to the introduction of the database approach, which consolidates data from distinct files into databases that can be shared by a number of applications. A database can be defined as a collection of interrelated data from which users can efficiently retrieve the desired data.
- Database is an important asset of business. To design, use and maintain such important asset, many people are involved. The people who work with databases include the database users, system analysts, application programmers, and the database administrator.
- The Hierarchical data model is the oldest type of data model, developed by IBM in 1968. In this model, data is organized in a tree-like structure where each child node can have only one parent node.
- The first specification of the Network data model was presented by the Conference on Data Systems Languages in 1969. It is powerful but complicated. Like the hierarchical model, in a network model also, the data is represented by links. The link in a network data model represents an association between precisely two records.
- The Relational Data model was developed by E. F. Codd of IBM in 1970. Though both the Hierarchical and the Network models were more flexible as compared to the traditional file processing systems, they were still not flexible enough. These limitations resulted in the development of the Relational Data Model. In relational systems, creating a new database and modifying the existing database structures are easier and faster as compared to a network and hierarchical database.
- The most precious asset of an organization is its human resource. Managing it well leads to growth and prosperity and mismanagement results in losses. Human resource MIS (HRMIS) helps managers manage the HR of the organizations in a better manner.
- Marketing is the activity of reaching out to customers, communicating the offerings of the organization to them, selling the product or service and ensuring their satisfaction.

5.6 KEY TERMS

- **Database:** A collection of interrelated data from which users can efficiently retrieve the desired data
- **Database management system:** An integrated set of programs used to create and maintain a database

- **Recruitment:** It is a regular activity in an organization that involves the selection of people for suitable jobs.

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5.7 SELF-ASSESSMENT QUESTIONS AND EXERCISES

Short-Answer Questions

1. Name a few vulnerabilities of systems.
2. Who are hackers?
3. What is SPOOLing?
4. What are the advantages of the network data model?
5. What are the sub-activities of the marketing function?
6. Why is publicity of a product important for a company?
7. State the process of recruitment.
8. What is information explosion?

Long-Answer Questions

1. Discuss the main concept of multiprogramming.
2. Briefly explain the data hierarchy with the help of diagram.
3. Write a note on system analysts and application programmers.
4. Describe the three levels of abstraction in the DBMS architecture.
5. Discuss about the typical information systems with the help of appropriate examples.
6. Briefly explain the various functions of information systems.
7. Explain the need and challenges of macro-level information systems.

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