MODULE V
TECHNOLOGY OF INFORMATION SYSTEM

INTRODUCTION

The development of modern information system is s complex process. It needs knowledge, know-how, skills and technology in almost all the disciplines. The developer, designer and the user must be knowledgeable in their respective area of functions and responsibilities. As information system are being demanded for online real time usage in business management, its development requires through understanding of the business and the manner in which it is executed. Further, different technologies, other than the information technology are used for providing input to the information systems.

Definition

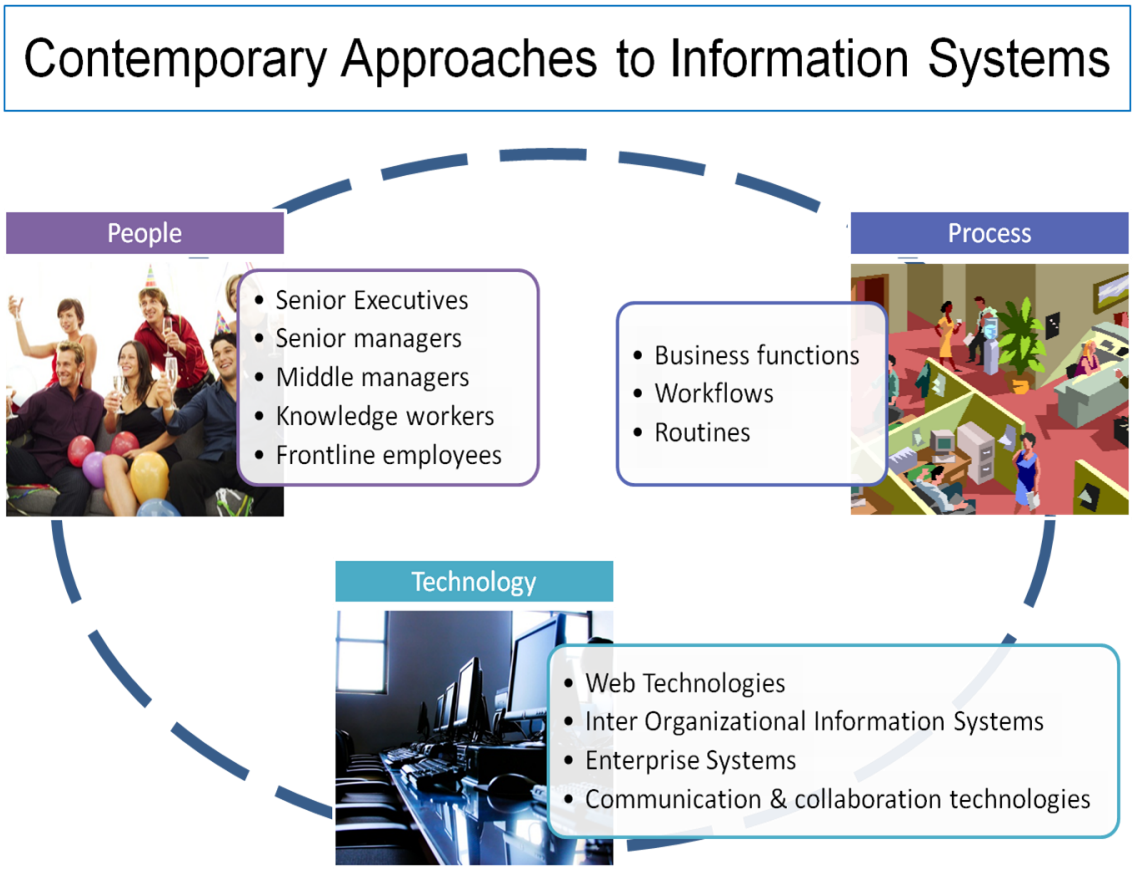
Information systems are interrelated components working together to collect, process, store, and disseminate information to support decision making, coordination, control, analysis, and visualization in an organization. An information system is a human activity system, which may or may not involve the use of computer system. Also in addition to supporting decision making, information system helps workers and managers to analyze complex problems to develop new product and to integrate various modules and departments.

An information system can be defined technically as a set of interrelated components that collect, process, store and distribute information to support decision making and control in an organization. Another definition of an Information system (by Buckingham et al 1987) is: a system which assembles stores, processes and delivers information relevant to an organization in such a way that the information is accessible and useful to those who wish to use it including managers, staff, clients and citizens.

Understanding Information system as a Discipline

Information systems is an academic discipline of the complementary networks of hardware, software, users and business processes that organizations use to collect, filter, process, create and distribute data. Any specific information system aims to support planning, operations, management and decision making.

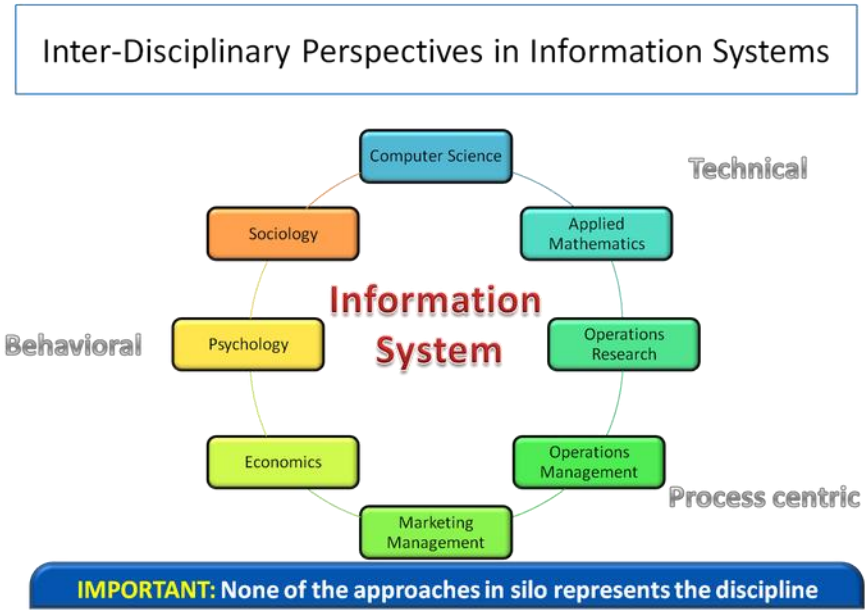
Contemporary approaches to understanding the domain of Information Systems interfaces a multi-disciplinary perspective. Essentially, in this lens, the usage of information technology is viewed through the lens of people, process and technology. So what is exactly meant when we talk about the nuances of analysis from the perspective of people, process and technology?



each of these perspective, we attempt to break down the case of analysis to its finer version. The image provides us a top-down plausible units of analysis when we are

considering such a perspective of analysis of Information Systems, which again are popularly called Management Information Systems.

Some researchers of the domain clearly demarcate between information systems, computer systems (or the discipline of Information Technology), and business processes (Denoted by functions, workflows and routines from an Operations Management perspective). Information systems typically include an ICT component but are not purely concerned with ICT, focusing instead on the end use of information technology. Information systems are also different from business processes as it interfaces with the same and help to control the performance of business processes. To this effect, the three inter-disciplinary focus are very different and yet converge to create the unique discipline of Information Systems.



THE INTERDEPENDENCE BETWEEN ORGANIZATIONS AND INFORMATION SYSTEMS

There is a growing interdependence between a firm's information systems and its business capabilities. Changes in strategy, rules, and business processes increasingly require changes in hardware, software, databases, and

telecommunications. Often, what the organization would like to do depends on what its systems will permit it to do.

Business firms invest heavily in information systems to achieve six strategic business objectives:

Operational excellence: Efficiency, productivity, and improved changes in business practices and management behavior

New products, services, and business models: A business model describes how a company produces, delivers, and sells a product or service to create wealth. Information systems and technologies create opportunities for products, services, and new ways to engage in business.

Customer and supplier intimacy: Improved communication with and service to customers' raises revenues and improved communication with suppliers lowers costs.

Improved decision making: Without accurate and timely information, business managers must make decisions based on forecasts, best guesses, and luck, a process that results in over and under-production of goods, raising costs, and the loss of customers.

Competitive advantage: Implementing effective and efficient information systems can allow a company to charge less for superior products, adding up to higher sales and profits than their competitors.

Survival: Information systems can also be a necessity of doing business. A necessity may be driven by industry-level changes, as in the implementation of ATMs in the retail banking industry. A necessity may also be driven by governmental regulations, such as federal or state statutes requiring a business to retain data and report specific information.

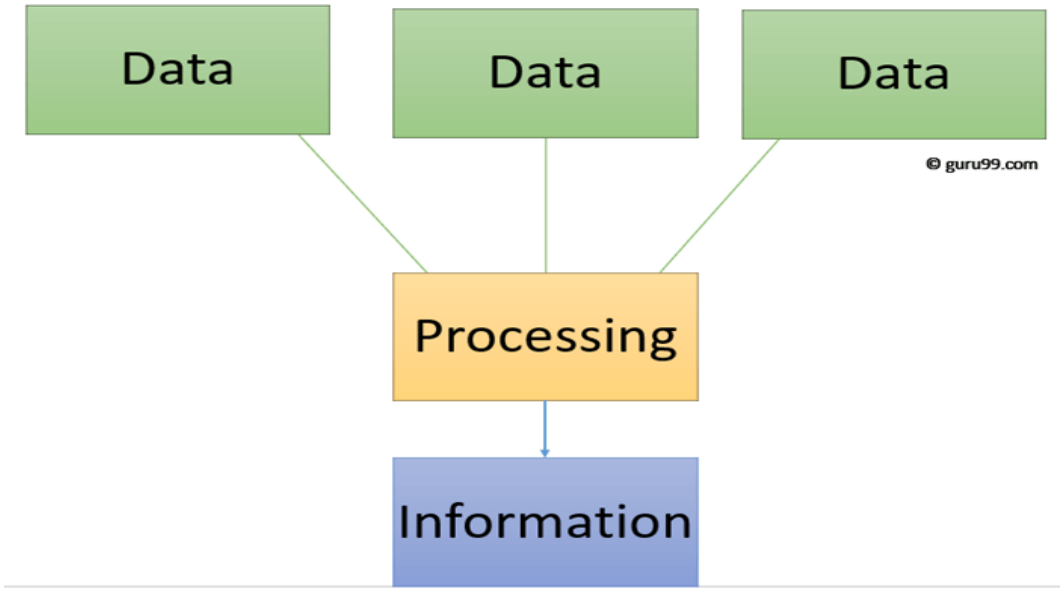
DATA AND INFORMATION

Data is the complete list of facts and details like text, observations, figures, symbols and description of things. It is the raw list of facts that are processed to gain information. The basic concept of data is associated with scientific research

collected by different research organizations while Information is the processed, organized and structured data. It provides context for data. However, both the terms are used together; information can be easily understood than data

What is data? - Data is a raw and unorganized fact that required to be processed to make it meaningful. Data can be simple at the same time unorganized unless it is organized. Generally, data comprises facts, observations, perceptions numbers, characters, symbols, image, etc. Data is always interpreted, by a human or machine, to derive meaning. So, data is meaningless. Data contains numbers, statements, and characters in a raw form

What is Information?- Information is a set of data which is processed in a meaningful way according to the given requirement. Information is processed, structured, or presented in a given context to make it meaningful and useful. It is processed data which includes data that possess context, relevance, and purpose. It also involves manipulation of raw data. Information assigns meaning and improves the reliability of the data. It helps to ensure undesirability and reduces uncertainty. So, when the data is transformed into information, it never has any useless details.



DATA PROCESSING

Data in its raw form is not useful to any organization. Data processing is the method of collecting raw data and translating it into usable information. It is usually performed in a step-by-step process by a team of data scientists and data engineers in an organization. The raw data is collected, filtered, sorted, processed, analyzed, stored and then presented in a readable format. Data processing is crucial for organizations to create better business strategies and increase their competitive edge. By converting the data into a readable format like graphs, charts and documents, employees throughout the organization can understand and use the data.

Data processing occurs when data is collected and translated into usable information. Usually performed by a data scientist or team of data scientists, it is important for data processing to be done correctly as not to negatively affect the end product or data output. Data processing starts with data in its raw form and converts it into a more readable format (graphs, documents, etc.), giving it the form and context necessary to be interpreted by computers and utilized by employees throughout an organization.

Data processing functions

Data processing may involve various processes, including:

Validation – Ensuring that supplied data is correct and relevant.

Sorting – "arranging items in some sequence and/or in different sets."

Summarization – reducing detailed data to its main points.

Aggregation – combining multiple pieces of data.

Analysis – the "collection, organization, analysis, interpretation and presentation of data."

Reporting – list detail or summary data or computed information.

Classification – separation of data into various categories

Stages of data processing

1. Data collection

Collecting data is the first step in data processing. Data is pulled from available sources, including data lakes and data warehouses. It is important that the data sources available are trustworthy and well-built so the data collected (and later used as information) is of the highest possible quality.

2. Data preparation

Once the data is collected, it then enters the data preparation stage. Data preparation, often referred to as "pre-processing" is the stage at which raw data is cleaned up and organized for the following stage of data processing. During preparation, raw data is diligently checked for any errors. The purpose of this step is to eliminate bad data (redundant, incomplete, or incorrect data) and begin to create high-quality data for the best business intelligence.

3. Data input

The clean data is then entered into its destination (perhaps a CRM like Salesforce or a data warehouse like Redshift), and translated into a language that it can understand. Data input is the first stage in which raw data begins to take the form of usable information.

4. Processing

During this stage, the data inputted to the computer in the previous stage is actually processed for interpretation. Processing is done using machine learning algorithms, though the process itself may vary slightly depending on the source of data being processed (data lakes, social networks, connected devices etc.) and its intended use (examining advertising patterns, medical diagnosis from connected devices, determining customer needs, etc.).

5. Data output/interpretation

The output/interpretation stage is the stage at which data is finally usable to non-data scientists. It is translated, readable, and often in the form of graphs, videos,

images, plain text, etc.). Members of the company or institution can now begin to self-serve the data for their own data analytics projects.

6. Data storage

The final stage of data processing is storage. After all of the data is processed, it is then stored for future use. While some information may be put to use immediately, much of it will serve a purpose later on. Plus, properly stored data is a necessity for compliance with data protection legislation like GDPR. When data is properly stored, it can be quickly and easily accessed by members of the organization when needed

Data Processing Methods

There are three main data processing methods - manual, mechanical and electronic.

Manual Data Processing

In this data processing method, data is processed manually. The entire process of data collection, filtering, sorting, calculation and other logical operations are all done with human intervention without the use of any other electronic device or automation software. It is a low-cost method and requires little to no tools, but produces high errors, high labor costs and lots of time.

Mechanical Data Processing

Data is processed mechanically through the use of devices and machines. These can include simple devices such as calculators, typewriters, printing press, etc. Simple data processing operations can be achieved with this method. It has much lesser errors than manual data processing, but the increase of data has made this method more complex and difficult.

Electronic Data Processing

Data is processed with modern technologies using data processing software and programs. A set of instructions is given to the software to process the data and

yield output. This method is the most expensive but provides the fastest processing speeds with the highest reliability and accuracy of output.

Data Processing Activities

The process of manipulation data to achieve the required objectives and results is called data processing. The software is used to process data. The software converts data into meaningful information. A series of actions or operations are performed on data to get the required output or result.

Different activities involved in data processing are as follows:

1. Data Capturing- The process of recording the data in some form is called data capturing. Data is captured before it can be processed. Data may be recorded on source documents. Data can also be given directly to the computer through input devices.

2. Data Manipulation- The process of applying different operations on data is called data manipulation. The following operations can be performed on data:

Classifying: A process of organizing data into classes or group data is called classifying. For example, the data in a college can be classified in two groups. The data of students may be in one group and of teachers may be in second group.

Calculation: A process of applying arithmetic operations on data is called calculation. The common calculations are addition, subtraction, multiplication and division etc.

Sorting: The process of arranging data in a logical sequence is called sorting. The data can be sorted numerically or alphabetically.

Summarizing: The process of reducing a large amount of data in a more concise and usable form is called summarizing. For example, people deposit money in banks daily. The data of bank can be summarizing to show the total money deposited in a particular month instead of showing all deposits.

3. Managing Output Result- The following activities can be performed on data after the data has been captured and manipulated:

Storage: The process of retaining data for future use is called data storage. Different storage medium are used to store the data such as hard disks and tapes etc.

Retrieval: The process of accessing or fetching the stored data is called data retrieval. The data can be retrieved as and when required. The retrieved data can be displayed in different forms such as reports, graphs and charts etc.

Communication: The process of transferring data from one location to another is called data communication. The data may be transferred to different locations for further processing. For example, the result can be sent to the students via email.

Reproduction: The process of copying or duplicating data is called reproduction of data. Data can be reproduced if different users need data at different locations.

TRANSACTION PROCESSING

A transaction process system and transaction processing are often contrasted with a batch process system and batch processing, where many requests are all executed at one time. The former requires the interaction of a user, whereas batch processing does not require user involvement. In batch processing the results of each transaction are not immediately available. Additionally, there is a delay while the many requests are being organized, stored and eventually executed. In transaction processing there is no delay and the results of each transaction are immediately available. During the delay time for batch processing, errors can occur. Although errors can occur in transaction processing, they are infrequent and tolerated, but do not warrant shutting down the entire system.

To achieve performance, reliability and consistency, data must be readily accessible in a data warehouse, backup procedures must be in place and the recovery process must be in place to deal with system failure, human failure, computer viruses, software applications or natural disasters A transaction processing system (TPS) is a software system, or software/hardware combination, that supports transaction processing.

Objectives

Organizations expect their TPS to accomplish a number of specific objectives such as:

- **Process data generated by and about transactions**: The primary objective of TPS is to capture, gather, process, and store transactions and to produce useful documents related to routine business activities to managers.
- **Maintain high degree of accuracy**: One of the objectives of TPS is error free data input and processing. In manual TPS, the resulting transactions were often inaccurate because human are fallible, resulting in wasted time, effort and requiring resources to correct them. In contrast, with computerized TPS, transaction processed appeared to be accurate or errors were minimized because accuracy checks were done by both humans and computer system.
- **Ensure data and information integrity**: TPS ensure that all the data and information stored in databases are always accurate, current, appropriate and up to date.
- **Produce timely documents and reports**: Manual TPS take longer time than computerized TPS to produce routine documents. Computerized TPS and the improvements in information technology (IT) allow transaction to be processed in a very short period of time.
- **Increase labour efficiency**: Manual TPS were labour intensive in which the process of business transaction is done by hand. With computerized TPS, firms can reduce the need of many labours as computer can replace human labours, thus saving the cost.
- **Help provide increased and enhanced services**: TPS assist organization in providing superior customer service. For example, computerized TPS enable customer to place orders for raw materials electronically and helps firms to track customer orders through all stages from order to delivery to receipt of payment. Thus, this allows firms to be more responsive to customer needs and queries.

Characteristics of Transaction Processing System

1. Rapid response: In order to shorten the waiting time of the users, TPSs are modified to process transactions instantly to ensure the data will be available in the shortest waiting time.

2. Reliability: Due to the involvement of cash, the reliability of TPS has to be in place. TPSs have to be designed in a way to avoid the transactions slip past the net in the same time remain themselves operating permanently. Also the failure rate has to be remained within the tolerance levels. With that comprehensive safeguards and disaster recovery systems have to be incorporated by the designed TPSs.

3. Inflexibility: Mistakes or errors can occur once the steps alter. To maximize the efficiency of the TPS, transactions have to be processed in the same order. With that, TPS interfaces have to be designed so that the identical data for each transaction can be acquired.

4. Controlled Processing: Transaction processing monitor is found at every end of the computer to ensure that the transactions are correctly inputted. Still it requires human controls on it. TPSs can be used even in modify the data and fraudulent the transactions. With that the user of the system has to be restricted only for people who have the authority.

Types of transactions Processing System

The settlement process should be standardized in order to maximize efficiency; each requires a custom transaction process in accordance with business strategies and processes. For this reason, there are two types of operations:

1. Batch Processing

Batch processing is the processing of transactions in a group or batch. No user interaction is required once batch processing is underway. This differentiates batch processing from transaction processing, which involves processing transactions one at a time and requires user interaction.

While batch processing can be carried out at any time, it is particularly suited to end-of-cycle processing, such as for processing a bank's reports at the end of a day or generating monthly or biweekly payrolls.

In this process, At first, data is collected, entered and processed. Afterward, it produces batch results. We can say Hadoop works on batch data processing. For input, process, and output, batch processing requires separate programs. Payroll and billing systems are beautiful examples of batch processing.
Let's understand batch processing with some scenario. While sales team/employees would gather information throughout a specified period of time. Afterward, all that information would be entered into the system all at once. This whole procedure is known as Batch Processing. Generally, it works for printing shipping labels, packing slips and payment processing. In other words, this method also means waiting to do everything at once. Also, it means relying on the ability of your system to handle it all.
We can say, the batch processing system

- Batch processing access to all data.
- It might compute something big and complex.
- Generally, it is very concerned with throughput. Rather than the latency of individual components of the computation.
- Batch processing has latency measured in minutes or more.

Advantages of Batch Processing

- Batch Processing is Ideal for processing large volumes of data/transaction. It also increases efficiency rather than processing each individually.
- Here, we can do processing independently. Even during less-busy times or at a desired designated time.
- For the organization by carrying out the process, it also offers cost efficiency.
- Also, allows a good audit trail.

Disadvantages of Batch Processing

- The time delay between the collection of data and getting the result after the batch process.
- In the batch processing master file is not always kept up to date.
- Here, a one-time process can be very slow.

2. Real-Time Processing

Real-Time Processing involves continuous input, process, and output of data. Hence, it processes in a short period of time. There are some programs which use such data processing type. For example, bank ATMs, customer services, radar systems, and Point of Sale (POS) Systems. Every transaction is directly reflected in the master file, with this data process. So, that it will always be up-to-date. If you want analytics results in real time, Spark Real-Time processing is key. We can feed data into analytics tools, by building data streams, as soon as it is generated. Moreover, it gets near-instant analytics results by using platforms like Spark Streaming**.**
In addition, for tasks like fraud detection, real-time processing is very useful. Basically, if process transaction data, we can detect that signal fraud in real time. Also, can stop fraudulent transactions before they take place, through real-time processing.

- Real-Time processing helps to compute a function of one data element. Also, can say it computes a smallish window of recent data.
- Real-Time processing computes something relatively simple
- While we need to compute in near-real-time, only seconds at most, we go for real-time processing.
- In real-time processing, computations are generally independent.
- They are asynchronous in nature. It means a source of data doesn't interact with the stream processing directly.

Advantages of Real-Time Processing

- While performing real-time processing, there is no significant delay in response.
- In real-time processing, information is always up to date. Hence, it makes the organization able to take immediate action. Also, when responding to an event, issue or scenario in the shortest possible span of time.
- It also makes the organization able to gain insights from the updated data. Even helps to detect patterns of possible identification of either opportunities or threats.

Disadvantages of Real-Time Processing

- Real-Time processing is very complex as well as expensive processing.
- Also turns out to be very difficult for auditing.
- Real-Time processing is a bit tedious processing.

APPLICATION PROCESSING

After data and transaction processing, the data finalized in these two stages gets posted on the affected files. Application processing is designed to process more than one type of transactions to bring out the specific business results in one or more business functions. This processing is carried out once the transaction is processed for its validity. Let us take an inventory application which requires the receipt and issue transactions duly validated for inventory processing. When these two transactions are processed, the inventory is updated for receipts and issues giving the net balance at the end of the processing for each item in the inventory are updated for receipts and issues giving the net balance at the end of the processing for each item in the inventory.

The application processing means the use of transaction data for bringing out a particular status. The application could be designed to change the number of different files holding a variety of information. The application can be designed for status updation and the status triggered actions in the related field of the application. For example, if the number of work orders are on `hold' for no material to process.

The scope of application processing can be made diverse by incorporating different transactions from the same application area or associated areas. For example, the inventory and purchase application can be processed together for vendor evaluation, item valuation and payable accounting. The scope of the application can be made diverse, if it is foreseen from the design stage. At this stage necessary inputs are provided in the transaction which can be used at a later data in the other application. The advent of communication technology and its embedded use in application processing extended its scope beyond the boundaries of the organization. The application can be designed for processing the results, updating of the business status, for triggering predefined actions and also communicating with the affected agencies located within the outside the organization.

INFORMATION SYSTEM PROCESS

The system processing is at a higher level, over the application for processing. The system is defined as a product made up of several applications set in orderly manner to produce a higher level information output different than the output of the application processing.

For example, the financial system is a product of finance, sales and purchase accounting application. Normally the system processing addresses the management issues of the business. In the financial system, processing is done for cash management, asset and liability management, working capital management, etc. Applications which are used for system processing are the finance transaction accounting the fixed asset processing, the receivables and payables processing, the sales and purchase accounting, etc. On the platform of these applications the system is processed for the analysis of a number of aspects of the finance management. It provides an insight into the funds flow, the sources and the uses of funds, profitability and productivity of the business.

The basic management functions are same, i.e., finance, materials, production or service, personnel and sales, etc. In all the business.

However, these functions are executed in different manners on account of the following factors:

- Nature of business (trading or manufacturing);
- The type of business (product or service);
- The complexity of business (multiple locations, divisions, products, etc.);
- Management style (autocratic, participative);
- Decision making (centralized, decentralized and empowered); and
- Quality of the organization and the people (learning and positive proactive work culture).

In the information system processing, the underlying design and architecture would vary giving due regard to the specifics and specialties of that business. Though all the businesses need a trial balance, a balance sheet, an income statement, the payables and receivables statement and the expense analysis, etc., the chart of account in each case would be different and typical to that particular business only.

This entire work of ascertaining the information needs to determination of the system design and architecture is called System Engineering.

System Engineering not only deals with applications and transactions but also with the various technologies which are used in the system implementation. The data acquisition technologies such as the bar code readers, the hand held terminals, the process embedded data loggers, the image processors, the digitizers, etc., are used for capturing the data inputs.

OLAP (ONLINE ANALYTICAL PROCESSING)

Online Analytical Processing (OLAP) is a category of software that allows users to analyze information from multiple database systems at the same time. It is a technology that enables analysts to extract and view business data from different points of view.
Analysts frequently need to group, aggregate and join data. These operations in relational databases are resource intensive. With OLAP data can be pre-calculated and pre-aggregated, making analysis faster.

How does it work?

A Data warehouse would extract information from multiple data sources and formats like text files, excel sheet, multimedia files, etc.
The extracted data is cleaned and transformed. Data is loaded into an OLAP server (or OLAP cube) where information is pre-calculated in advance for further analysis.

Basic analytical operations of OLAP

Four types of analytical operations in OLAP are:

1. Roll-up
2. Drill-down
3. Slice and dice
4. Pivot (rotate)

1. Roll-up: Roll-up is also known as "consolidation" or "aggregation." The Roll-up operation can be performed in 2 ways

- Reducing dimensions

- Climbing up concept hierarchy. Concept hierarchy is a system of grouping things based on their order or level.

2. Drill-down: In drill-down data is fragmented into smaller parts. It is the opposite of the rollup process. It can be done via

- Moving down the concept hierarchy
- Increasing a dimension

3. Slice: This enables an analyst to take one level of information for display

4. Dice: This allows an analyst to select data from multiple dimensions to analyze

5. Pivot: Analyst can gain a new view of data by rotating the data axes of the cube

Types of OLAP System

1. Relational OLAP (ROLAP): ROLAP is an extended RDBMS along with multidimensional data mapping to perform the standard relational operation.

2. Multidimensional OLAP (MOLAP): MOLAP Implements operation in multidimensional data.

3. Hybrid Online Analytical Processing (HOLAP): In HOLAP approach the aggregated totals are stored in a multidimensional database while the detailed data is stored in the relational database. This offers both data efficiency of the ROLAP model and the performance of the MOLAP model.

Advantages of OLAP

- OLAP is a platform for all type of business includes planning, budgeting, reporting, and analysis.
- Information and calculations are consistent in an OLAP cube. This is a crucial benefit.
- Quickly create and analyze "What if" scenarios
- Easily search OLAP database for broad or specific terms.
- OLAP provides the building blocks for business modeling tools, Data mining tools, performance reporting tools.

- Allows users to do slice and dice cube data all by various dimensions, measures, and filters.
- It is good for analyzing time series.
- Finding some clusters and outliers is easy with OLAP.
- It is a powerful visualization online analytical process system which provides faster response times

Disadvantages of OLAP

- OLAP requires organizing data into a star or snowflake schema. These schemas are complicated to implement and administer
- You cannot have large number of dimensions in a single OLAP cube
- Transactional data cannot be accessed with OLAP system.
- Any modification in an OLAP cube needs a full update of the cube. This is a time-consuming process

TQM OF INFORMATION SYSTEM

The objective of the Total Quality Management (TQM) in the information system design is to assure the quality of information. This is done by ensuring, verifying, and maintaining software integrity through an appropriate methodology choice amongst the technology, design and architecture. It institutes appropriate procedures with checks and control in all the processes of information systems development. It ensures that the scope and the objective of the system, choice of the design architecture and development methodology and further quality ensuring the processes and planned implementation methodologies are correctly chosen.

The quality of information is governed by the quality of the information processing system design. The perception of good quality is that of a customer or a user of the information system and not that of the conceiver, the planner or the designer of the information system.

The quality of the information and the systems which generate that information will be rated high provided it assures:

- A precise and an accurate information
- A high level response in an interactive processing
- User friendly operations

- Reliability of information
- An ease of maintenance

A single most important measure of quality assurance is the level of user satisfaction it attains. The user satisfaction is highest if it meets his information needs on a continuing basis in a dynamic business environment.

In the process of achieving user satisfaction, the information system must be conceived with business focus and orientation. It must address the total scope of the business with specific attention in the areas of core competence and mission critical applications. The choice of the Information Technology strategy should be such that it supports the business strategy implementation to achieve business goals and mission.

Concept of TQM

TQM addresses all these requirements of the information systems development. It ensures that the information system design is flexible, bug free and easy to maintain with the changing needs.

In the TQM application to information systems, the technologies play a vital role. We can make two parts of these technologies. First, as a current and the second one as the emerging technologies. The current technologies are database management, distributed data processing, object orientation, parallel processing, data warehousing and replication, networks and communication.

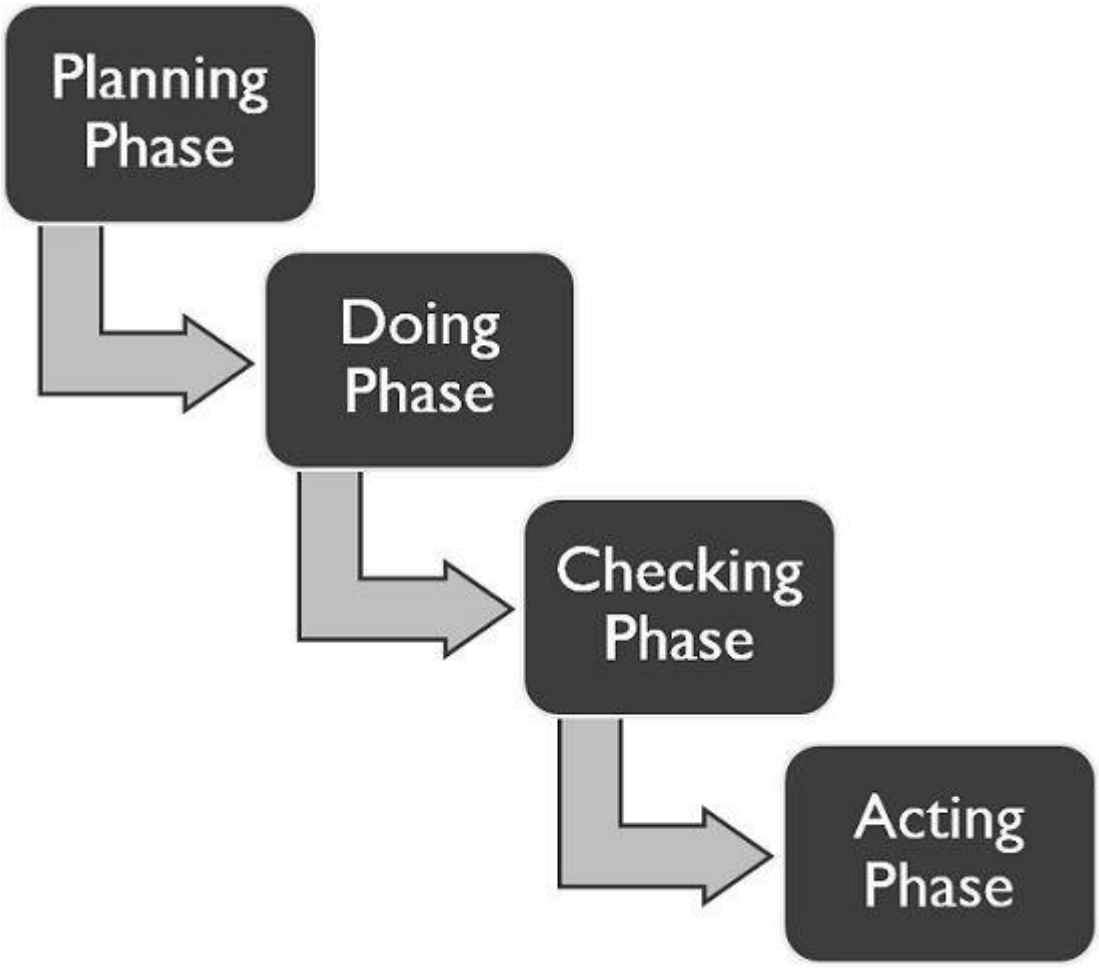
Advantages of TQM

- Strengthened competitive position
- Adaptability to changing or emerging market conditions and to environmental and other government regulations
- Higher productivity
- Enhanced market image
- Elimination of defects and waste
- Reduced costs and better cost management
- Higher profitability

- Improved customer focus and satisfaction
- Increased customer loyalty and retention
- Increased job security
- Improved employee morale
- Enhanced shareholder and stakeholder value
- Improved and innovative processes

Phases of Total Quality Management

There are four phases in total quality management:



1. Planning Phase: In this phase, the employees are required to discover the problems faced by them, during regular operations along with their root-cause. For this, comprehensive research is done by the employees to collect the relevant data, with a view to finding solutions to their problems.

2. Doing Phase: At this stage, employees find out solutions to their problems, stated in the previous stage. Strategies are created and executed to cope with the problems experienced by the employees, while at work. Moreover, the evaluation of the usefulness of strategies and solutions are also done in this phase.

3. Checking Phase: The performance is analysed by making a comparison of before and after data, for validating the effectiveness of the processes and measuring the outcome.

4. Acting Phase: The outcome of the process is documented at this stage, and the employees prepare themselves to confront other challenges.

REAL TIME SYSTEM

Real time system means that the system is subjected to real time, i.e., response should be guaranteed within a specified timing constraint or system should meet the specified deadline. For example: flight control system, real time monitors etc.

Types of real time systems based on timing constraints:

1. Hard real time system

This type of system can never miss its deadline. Missing the deadline may have disastrous consequences. The usefulness of result produced by a hard real time system decreases abruptly and may become negative if tardiness increases. Tardiness means how late a real time system completes its task with respect to its deadline. Example: Flight controller system.

2. Soft real time system

This type of system can miss its deadline occasionally with some acceptably low probability. Missing the deadline has no disastrous consequences. The usefulness of result produced by a soft real time system decreases gradually with increase in tardiness. Example: Telephone switches.

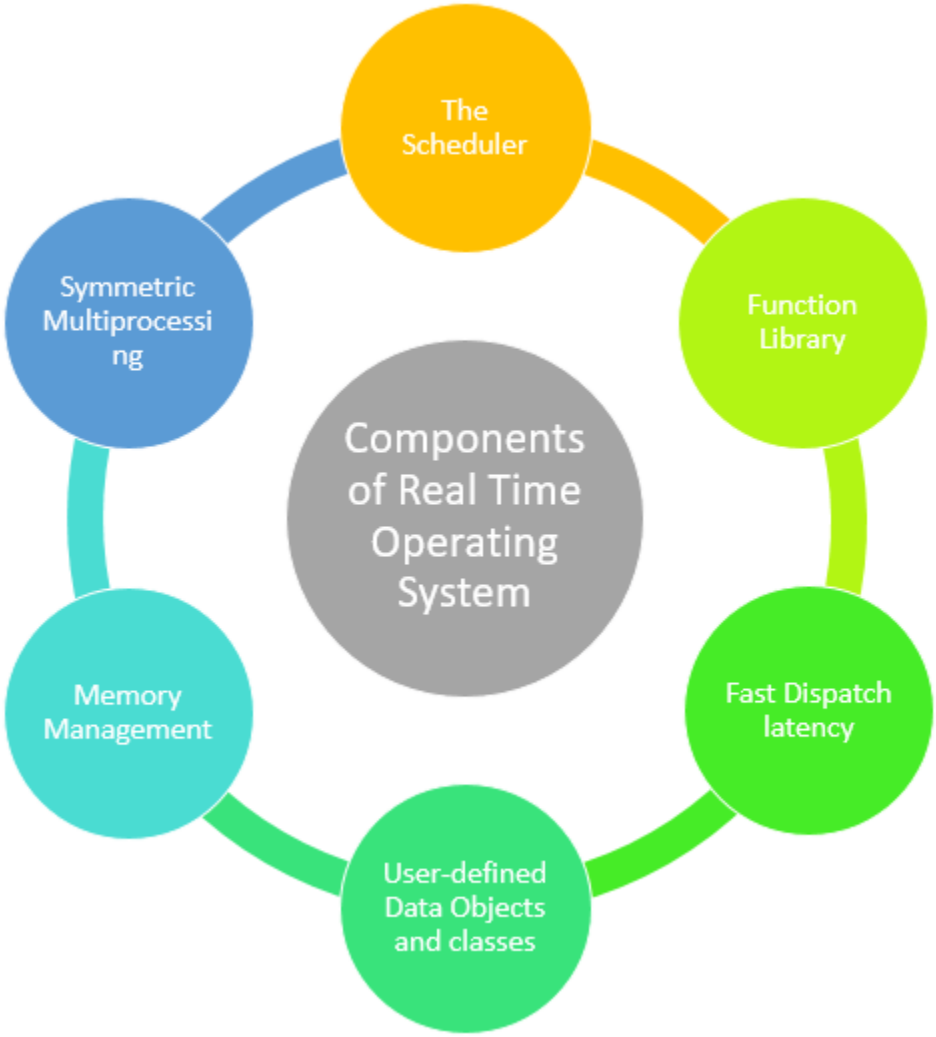
3. Reference model of real time system: Our reference model is characterized by three elements:

- A workload model: It specifies the application supported by system.
- A resource model: It specifies the resources available to the application.
- Algorithms: It specifies how the application system will use resources.

REAL-TIME OPERATING SYSTEM (RTOS)

Real-time operating system (RTOS) is an operating system intended to serve real time application that process data as it comes in, mostly without buffer delay. The full form of RTOS is Real time operating system. In a RTOS, Processing time requirement are calculated in tenths of seconds increments of time. It is time-bound system that can be defined as fixed time constraints. In this type of system, processing must be done inside the specified constraints. Otherwise, the system will fail.

Components of RTOS



Here, are important Component of RTOS

The Scheduler: This component of RTOS tells that in which order, the tasks can be executed which is generally based on the priority.

Symmetric Multiprocessing (SMP): It is a number of multiple different tasks that can be handled by the RTOS so that parallel processing can be done.

Function Library: It is an important element of RTOS that acts as an interface that helps you to connect kernel and application code. This application allows you to send the requests to the Kernel using a function library so that the application can give the desired results.

Memory Management: this element is needed in the system to allocate memory to every program, which is the most important element of the RTOS.
Fast dispatch latency: It is an interval between the termination of the task that can be identified by the OS and the actual time taken by the thread, which is in the ready queue that has started processing.

User-defined data objects and classes: RTOS system makes use of programming languages like C or C++, which should be organized according to their operation.

CASE TOOL

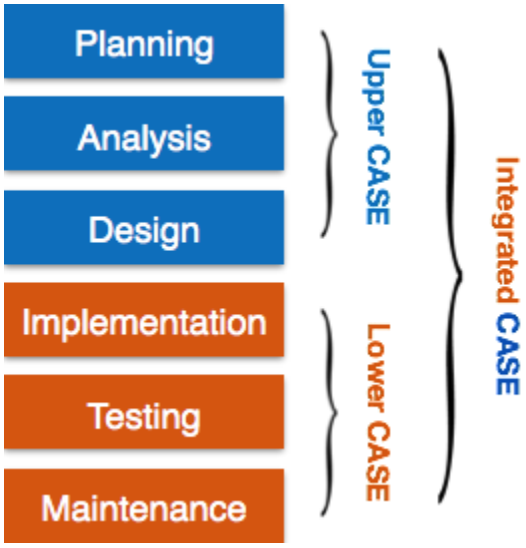
Computer aided software engineering (CASE) is the implementation of computer facilitated tools and methods in software development. CASE is used to ensure a high-quality and defect-free software. CASE ensures a check-pointed and disciplined approach and helps designers, developers, testers, managers and others to see the project milestones during development.
CASE can also help as a warehouse for documents related to projects, like business plans, requirements and design specifications. One of the major advantages of using CASE is the delivery of the final product, which is more likely to meet real-world requirements as it ensures that customers remain part of the process.
CASE illustrates a wide set of labor-saving tools that are used in software development. It generates a framework for organizing projects and to be helpful in enhancing productivity. There was more interest in the concept of CASE tools years ago, but less so today, as the tools have morphed into different functions, often in reaction to software developer needs. The concept of CASE also received a heavy dose of criticism after its release.

Components of CASE Tools

CASE tools can be broadly divided into the following parts based on their use at a particular SDLC stage:

- **Central Repository** - CASE tools require a central repository, which can serve as a source of common, integrated and consistent information. Central repository is a central place of storage where product specifications, requirement documents, related reports and diagrams, other useful

information regarding management is stored. Central repository also serves as data dictionary.



- **Upper Case Tools** - Upper CASE tools are used in planning, analysis and design stages of SDLC.
- **Lower Case Tools** - Lower CASE tools are used in implementation, testing and maintenance.
- **Integrated Case Tools** - Integrated CASE tools are helpful in all the stages of SDLC, from Requirement gathering to Testing and documentation.

CASE tools can be grouped together if they have similar functionality, process activities and capability of getting integrated with other tools

Types of CASE Tools:

1. **Diagramming Tools:**
   It helps in diagrammatic and graphical representations of the data and system processes. It represents system elements, control flow and data flow among different software components and system structure in a pictorial form.
   For example, Flow Chart Maker tool for making state-of-the-art flowcharts.

2. **Computer Display and Report Generators:**
   It helps in understanding the data requirements and the relationships involved.

3. **Analysis Tools:**
   It focuses on inconsistent, incorrect specifications involved in the diagram and data flow. It helps in collecting requirements; automatically check for any irregularity, imprecision in the diagrams, data redundancies or erroneous omissions.
   For example,
   (i) Accept 360, Accompa, CaseComplete for requirement analysis.

   (ii) Visible Analyst for total analysis.

4. **Central Repository:**
   It provides the single point of storage for data diagrams, reports and documents related to project management.

5. **Documentation Generators:**
   It helps in generating user and technical documentation as per standards. It creates documents for technical users and end users.
   For example, Doxygen, DrExplain, Adobe RoboHelp for documentation.

6. **Code Generators:**
   It aids in the auto generation of code, including definitions, with the help of the designs, documents and diagrams.

Why CASE tools are developed?

CASE tools are designed to enhance and upgrade the computing system adopted and used. This is very important with regards to the dependence on a computer-based environment for business and/or personal pursuits. It is an important part of various business growth strategies. The CASE tools are developed for the following reasons:

- Firstly Quick Installation.
- Time Saving by reducing coding and testing time.
- Enrich graphical techniques and data flow.
- Optimum use of available information.
- Enhanced analysis and design development.
- Create and manipulate documentation.
- Transfer the information between tools efficiently.

- The speed during the system development increased.

Use of CASE tools by organizations

Here are the ways where the CASE tools are used:

1. **To facilitate single design methodology:** CASE tools help the organization to standardize the development process. It also facilitates coordinated development. Integration becomes easy as common methodology is adopted.

2. **Rapid Application Development:** To improve the speed and quality of system development organizations use CASE tools.

3. **Testing:** CASE tools help in improving the testing process through automated checking and simplified program maintenance.

4. **Documentation**: In a traditional software development process, the quality of documentation at various stages depends on the individual. At various stages of SDLC CASE tools improve the quality and uniformity of documentation. It also ensures the completeness of the documentation.

5. **Project Management:** It improves project management activity and to some extent automates various activities involved in project management.

6. **Reduce the maintenance cost:** Use of CASE tools makes the software easy to maintain and hence reduce the maintenance costs.

7. **Increase Productivity**: Automation of various activities of system development and management processes increases productivity of the development team.

Role of CASE tools:

CASE tools play a major role in the following activities:

- Project management
- Data dictionary
- Code generation
- User interface design
- Schema generation

- Creation of meta-data for data warehouse
- Reverse engineering
- Re-engineering
- Document generation
- Version control
- OO analysis and design
- Software testing
- Data modeling
- Project scheduling
- Cost estimation

Advantages of the CASE approach:

- As special emphasis is placed on redesign as well as testing, the servicing cost of a product over its expected lifetime is considerably reduced.

- The overall quality of the product is improved as an organized approach is undertaken during the process of development.

- Chances to meet real-world requirements are more likely and easier with a computer-aided software engineering approach.

- CASE indirectly provides an organization with a competitive advantage by helping ensure the development of high-quality products.

Disadvantages of the CASE approach:

- **Cost**: Using case tool is a very costly. Mostly firms engaged in software development on a small scale do not invest in CASE tools because they think that the benefits of CASE are justifiable only in the development of large systems.
- **Learning Curve**: In most cases, programmer's productivity may fall in the initial phase of implementation, because user need time to learn the technology. Many consultants offer training and on-site services that can be important to accelerate the learning curve and to the development and use of the CASE tools.

- **Tool Mix**: It is important to build an appropriate selection tool mix to urge cost advantage CASE integration and data integration across all platforms is extremely important.

I- CASE

- It offers automated systems development environment that provides numerous tools to create diagrams, forms and reports
- All tools share one common user interface
- User has the feeling of working on one tool
- Provide analysis, reporting and code generation facilities
- Seamlessly shares and integrate data across and between tools
- Repository is a central place to share information that is to be shared between various tools