Foundations for Systems Development:

The System Development Environment

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- Basic Terminologies:
- Introduction
- A Modern Approach to Systems Analysis and Design
- Developing Information Systems
- Systems Development Life Cycle(SDLC)
- The Heart of the Systems Development Process
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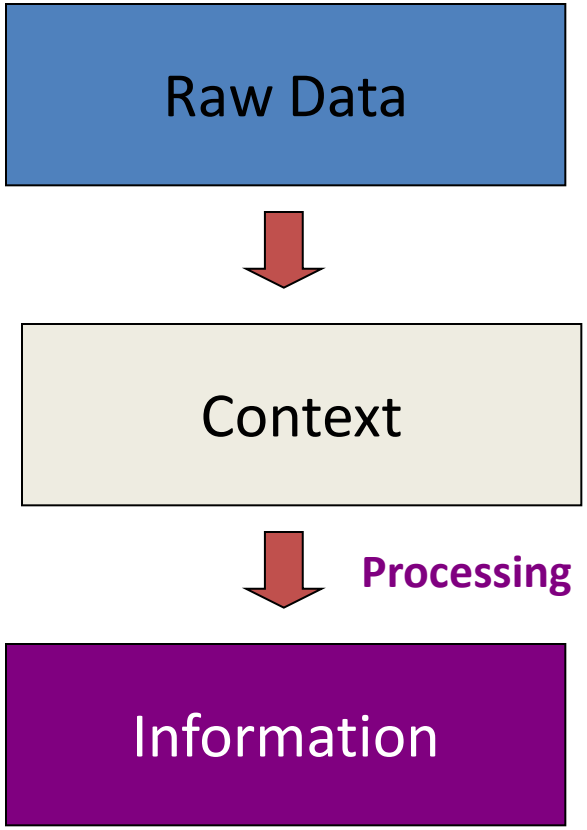
Introduction: Data Vs Information

- **Data** is raw unprocessed facts and figures that have no context or purposeful meaning.
- Data are raw facts about the organization and its business transactions.
- Most data items have little meaning and use by themselves.
- **Information** is processed data that has meaning .
- Information is data that has been refined and organized by processing and purposeful intelligence.

Comparision

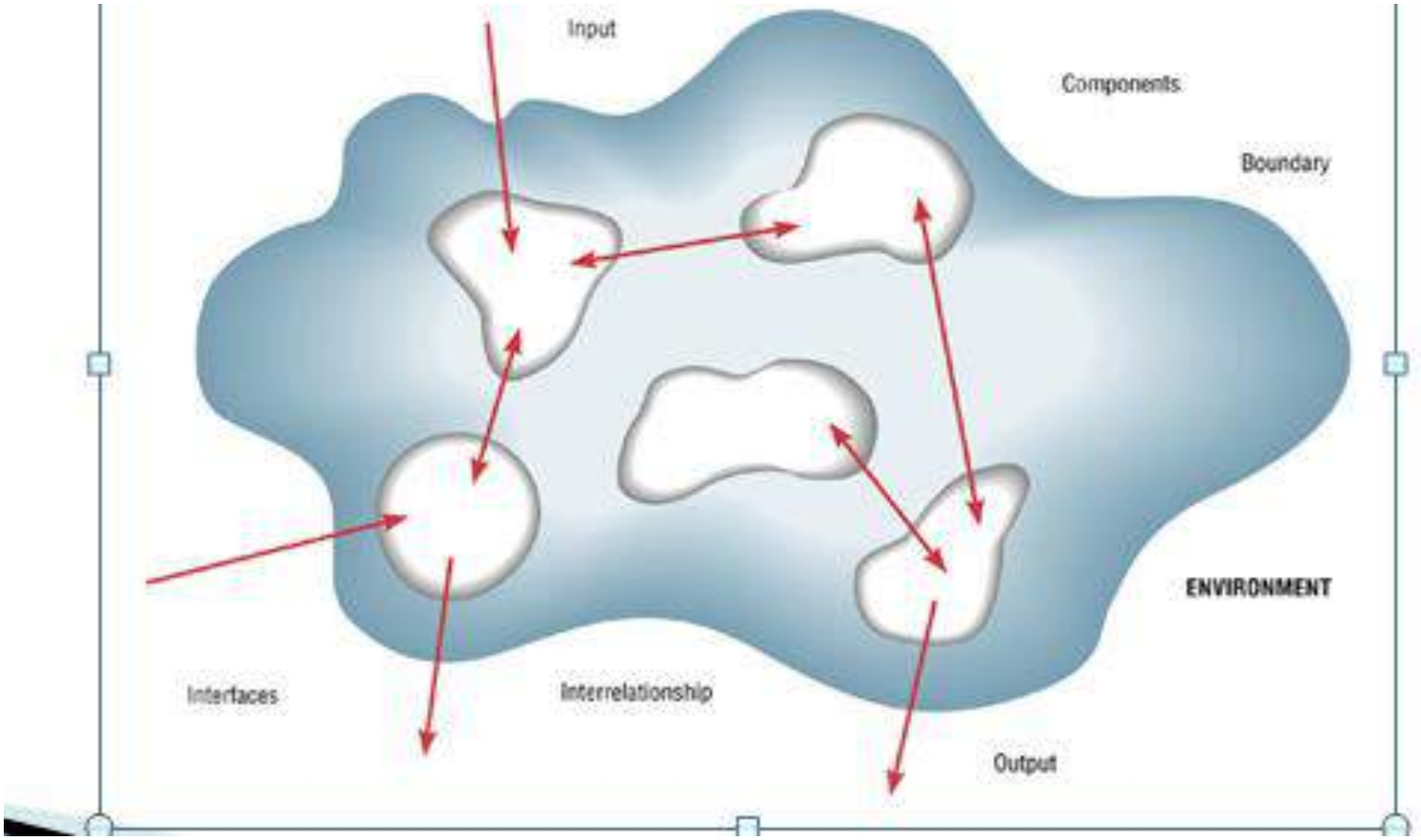
- Data is used as input for the computer system. Information is the output of data.
- Data is unprocessed facts figures. Information is processed data.
- Data doesn’t depend on Information. Information depends on data.
- Data is not specific. Information is specific.
- Data is a single unit. A group of data which carries news and meaning is called Information.
- Data doesn’t carry a meaning. Information must carry a logical meaning.
- Data is the raw material. Information is the product.


Raw Data
Context
Processing
Information

System and Information System(IS)

- A **system** is a set of related components that produces specific results.
- A system is an interrelated set of business procedures used within one business unit working together for a purpose
- A system exists within an environment. A boundary separates a system from its environment.
- A system has nine characteristics which are as follows:
  - Components
  - Interrelated Components
  - Boundary
  - Purpose
  - Environment
  - Interfaces
  - Input
  - Output
  - Constraints

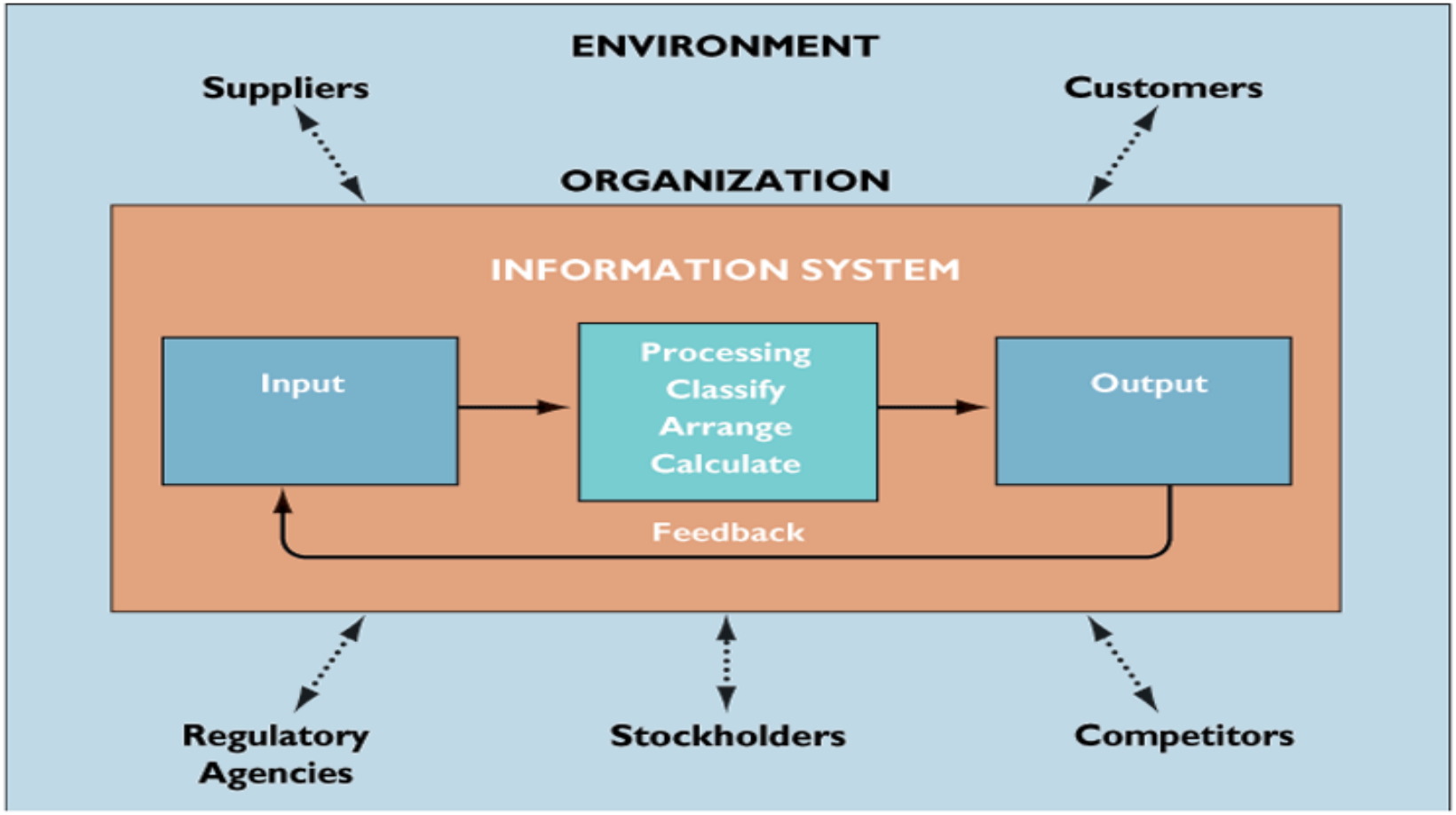
Characteristics of a System



- **An information system (IS)** is an arrangement of people, data, processes, communications, and information technology that interact to support and improve day-to-day operations in a business, as well as support the problem-solving and decision-making needs of management and users.

The Components of an Information System:

- **Input:** activity of gathering and capturing raw data
- **Processing:** converting or transforming data into useful outputs
- **Output:** production of useful information, usually in form of documents and reports
- **Feedback:** output used to make changes to input or processing activities


ENVIRONMENT
Suppliers
Customers
ORGANIZATION
INFORMATION SYSTEM
Input
Processing
Classify
Arrange
Calculate
Output
Feedback
Regulatory Agencies
Stockholders
Competitors

Other terms

Information Technology:

- Information technology is a contemporary term that describes the combination of computer technology (hardware and software) with telecommunications technology (data, image, and voice networks).
  - Combination of hardware and software products and services that companies use to manage, access, communicate, and share information

Systems analysis:

Systems analysis is a problem-solving technique that decomposes a system into its component pieces f or the purpose of studying how well those component parts work and interact to accomplish their purpose.

Information systems analysis:

Information systems analysis is defined as those development phases in a project that primarily focus on the business problem, independent of any technology that can or will be used to implement a solution to that problem.

System analysis and design

- Complex organizational process
- Used to develop and maintain computer-based information systems
- Used by a team of business and systems professionals
- Information systems analysis and design is a complex, challenging, and stimulating organizational process that a team of business and systems professionals uses to develop and maintain computer-based information systems.
- It is complex organizational process whereby computer-based information systems are developed and maintained.

- **Systems analysis and design is a** step-by-step process for developing high-quality information systems.
- An **information system combines** information technology, people, and data to support business requirements.

- **Application Software**
  - **Computer software -result of systems analysis and design-**
  - **Designed to support organizational functions or processes**
- Software engineering processes have been developed to assist in analysis and design
  - Methodologies
    - Comprehensive, multi-step approaches to systems development
  - Techniques
    - Processes that are followed to ensure that work is well thought-out, complete and comprehensible to others on the project team
  - Tools
    - Computer programs to assist in application of techniques to the analysis and design process

- **Information Systems Analysis and Design**
  - **A method used by companies to create and maintain systems that perform basic business functions**
  - **Main goal is to improve employee efficiency by applying software solutions to key business tasks**
  - **A structured approach must be used in order to ensure success**

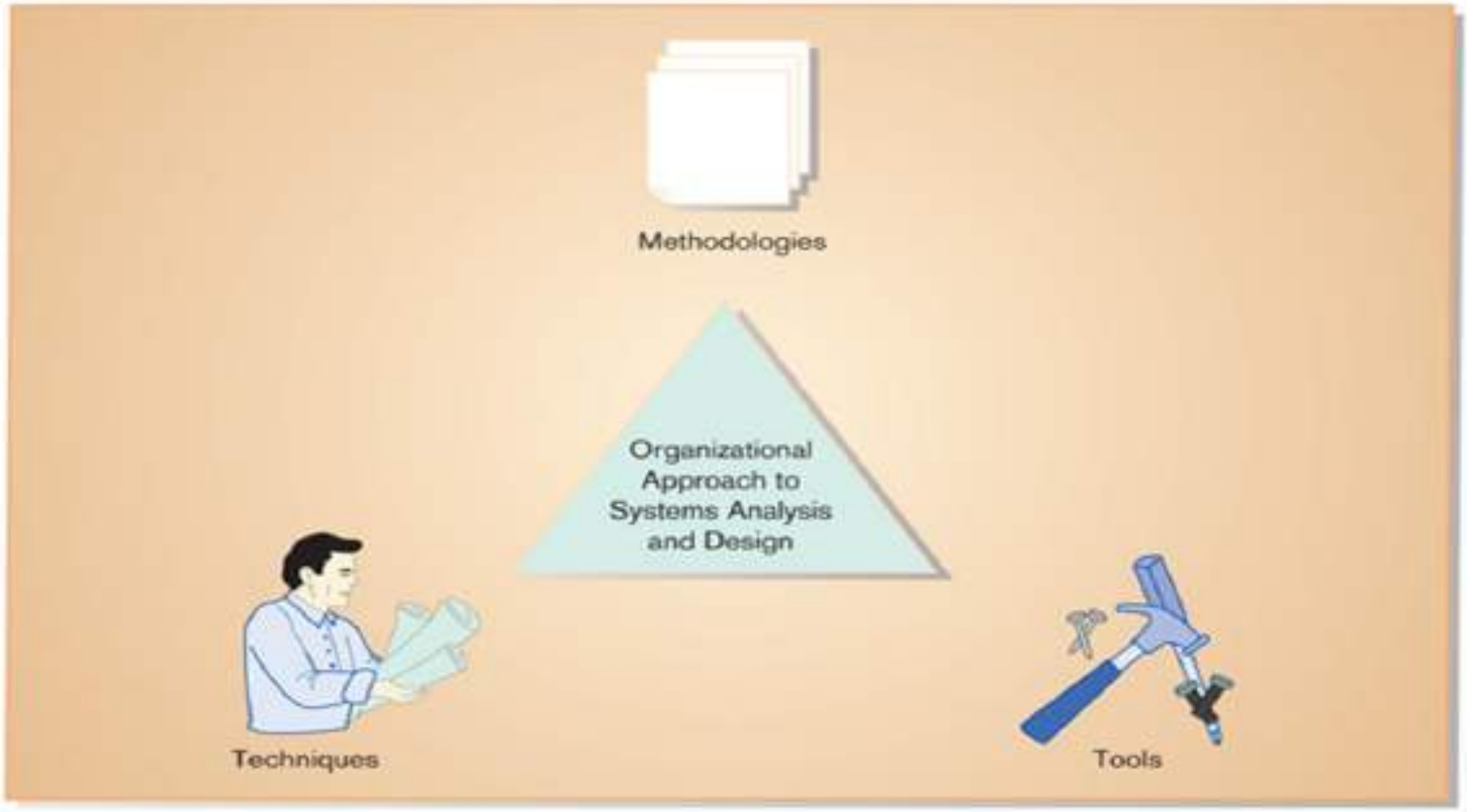
- System analyst:
- the organizational role most responsible for the analysis and design of IS.

Systems Analyst performs analysis and design based upon:

- Understanding of organization's objectives, structure and processes
- Knowledge of how to exploit information technology for advantage

Software Engineering Process

- A process used to create an information system
- Consists of:
  - Methodologies
    - A sequence of step-by-step approaches that help develop the information system
  - Techniques
    - Processes that the analyst follows to ensure thorough, complete and comprehensive analysis and design
  - Tools
    - Computer programs that aid in applying techniques


Methodologies
Organizational Approach to Systems Analysis and Design
Techniques
Tools

A Modern Approach to Systems Analysis and Design

- 1950s: focus on efficient automation of existing processes
- 1960s: advent of 3GL procedural or third-generation, faster and more reliable computers
- 1970s: system development becomes more like an engineering discipline
- 1980s: major breakthrough with 4GL, CASE tools, object oriented methods
- 1990s: focus on system integration, client/server platforms, Internet
- The new century: Web application development, wireless PDAs (personal digital assistant) , component-based applications

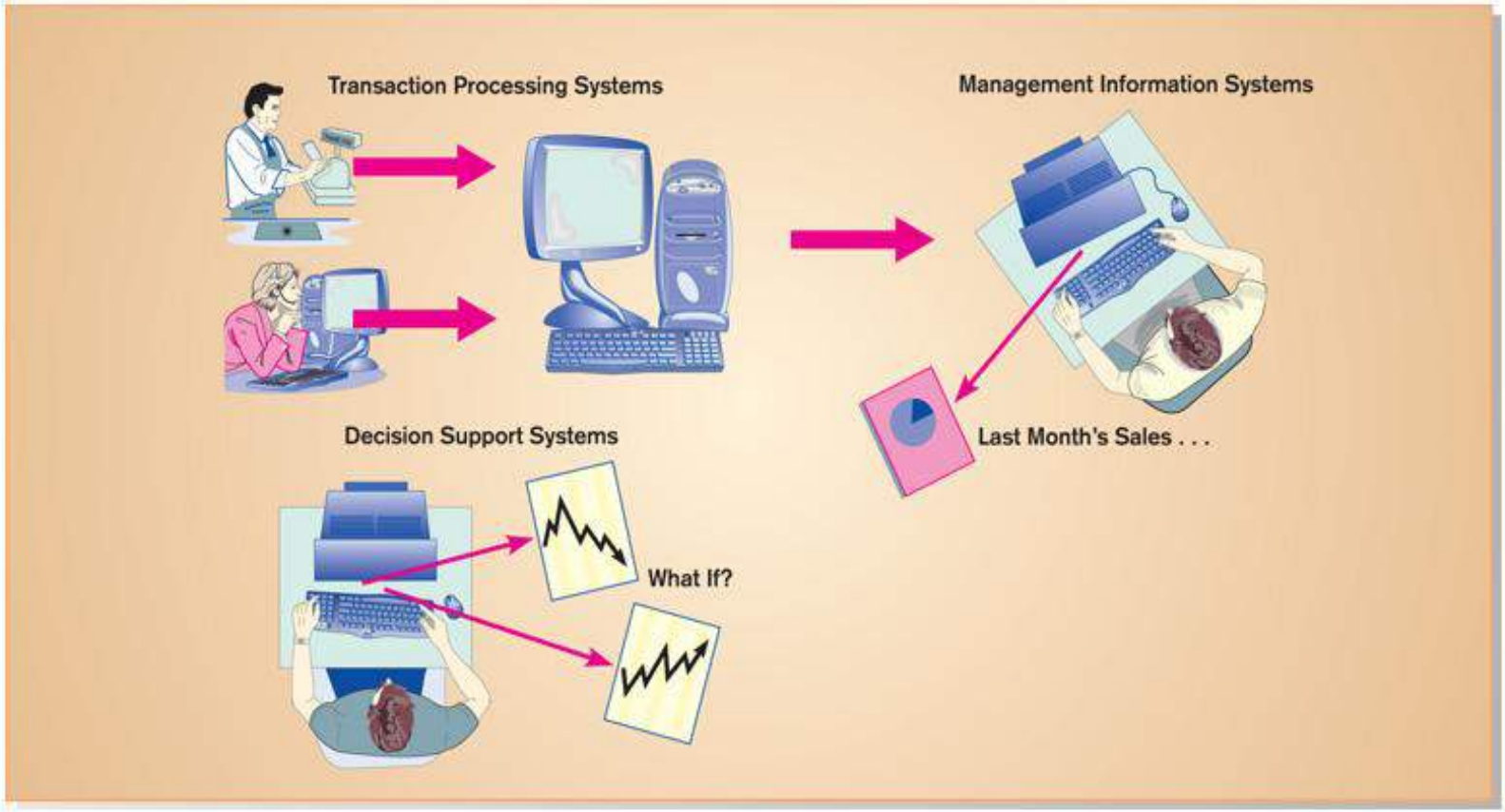
Process-Oriented Approach

- Focus is on flow, use and transformation of data in an information system
- Involves creating graphical representations such as data flow diagrams and charts
- Data are tracked from sources, through intermediate steps and to final destinations
- Natural structure of data is not specified
- Disadvantage: data files are tied to specific applications

Data-Oriented Approach

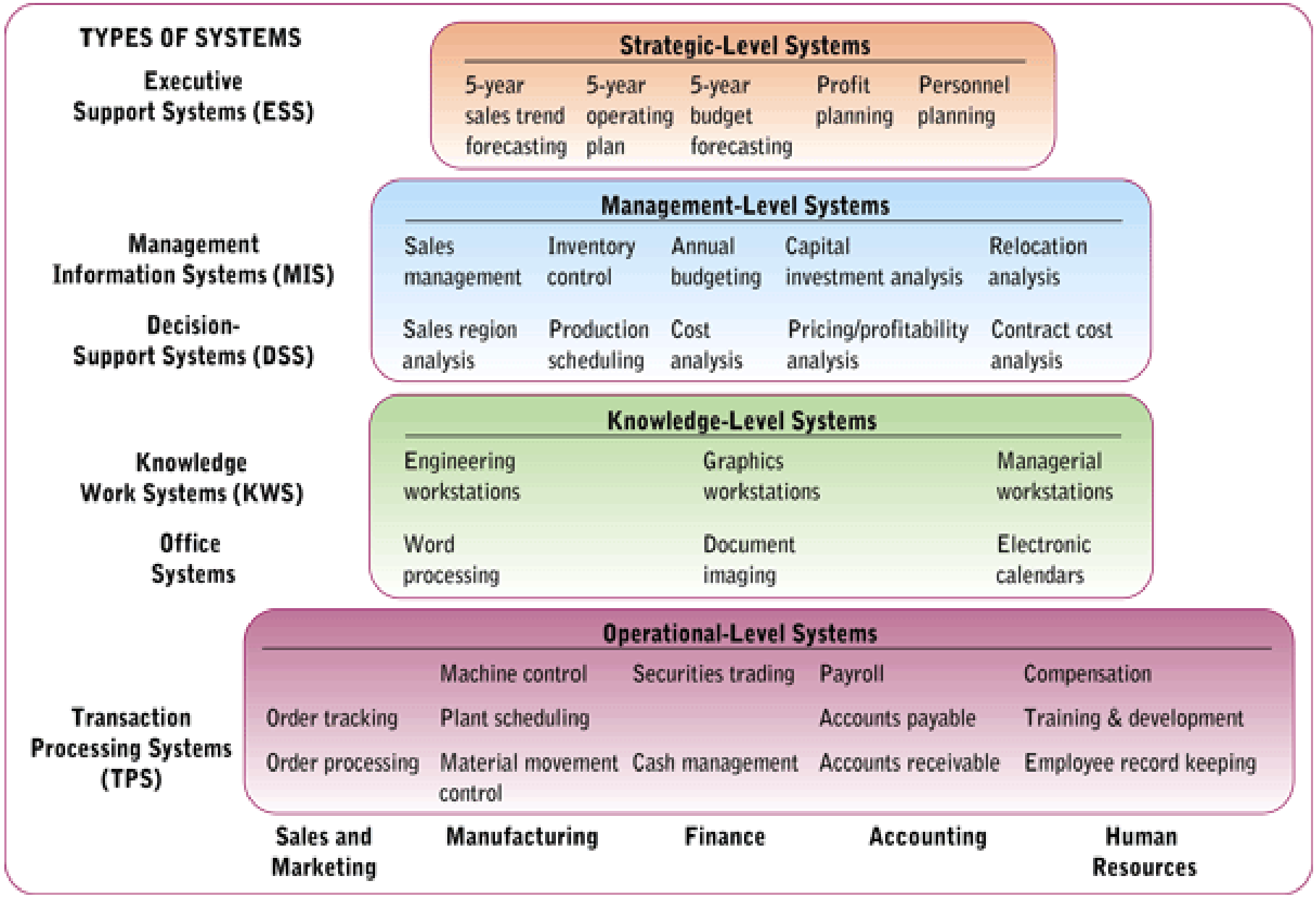
- Depicts ideal organization of data, independent of where and how data are used
- Data model describes kinds of data and business relationships among the data
- Business rules depict how organization captures and processes the data

Types of Information systems

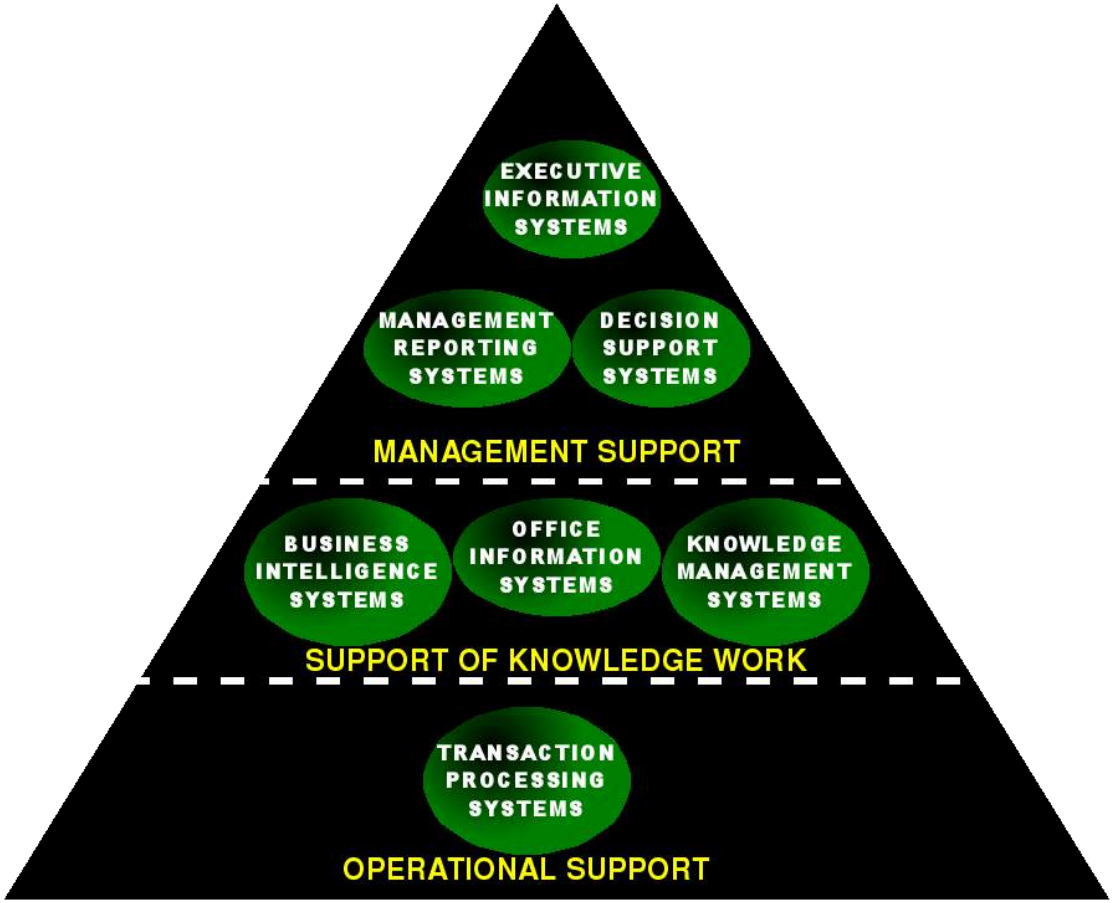


Types (classes)of Information Systems

- **Transaction Processing Systems (TPS)**
  - Process orientation
  - **Automate handling of data about business activities (transactions)**
  - **their goal to improve response time, efficiency, accuracy and using fewer people.**
- **Management Information Systems (MIS)**
  - Converts raw data from transaction processing system into meaningful form
  - Data orientation
- **Decision Support Systems (DSS)**
  - DSS Components: Database, model base, user dialogue
  - Involves data warehouses, executive information systems (EIS)
  - **Designed to help decision makers**
  - **Provides interactive environment for decision making**


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

Types of Information System

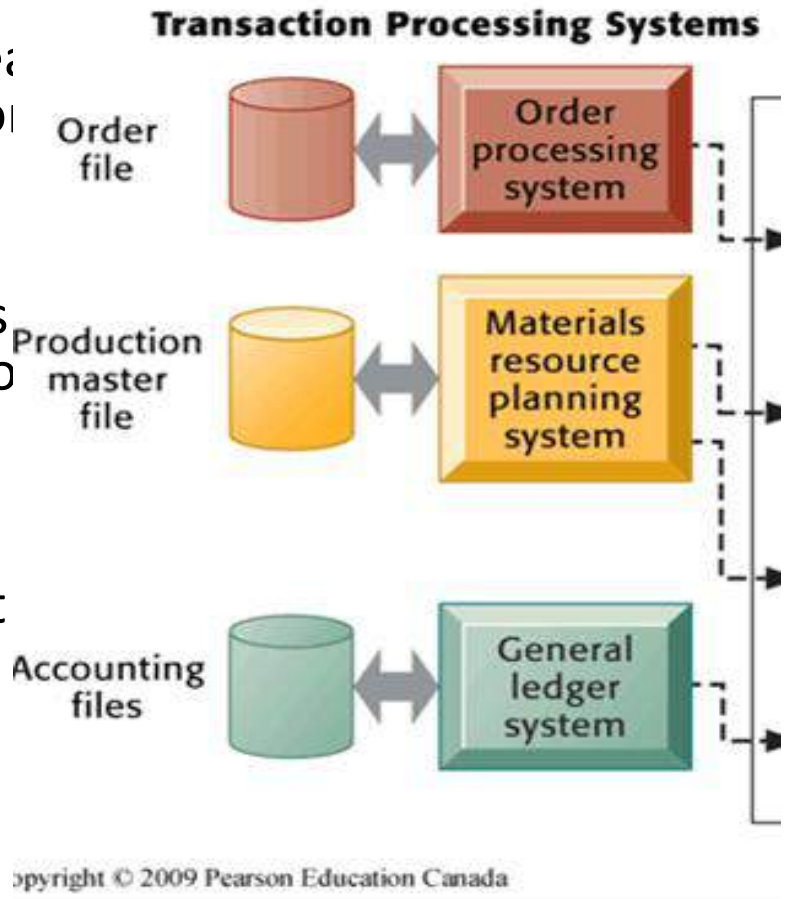


Transaction Processing Systems(TPS)

- Computerized systems that perform and record the *daily routine transactions* necessary to conduct the business; they serve the organization's *operational level*.
- Transaction processing systems are information system applications that capture and process data about business transactions.
- Includes data maintenance, which provides for custodial updates to stored data.
- Business process redesign (BPR) is the study, analysis, and redesign of fundamental business (transaction) processes to reduce costs and/or improve value added to the business

Transaction Processing System (TPS)

- TPS is a type of IS that manages data crea in everyday operations. This includes sto formatting, processing, retrieving, and creating some new aggregate data.
- Examples: purchasing transactions, sales orders, sales transactions, payroll, emplo data, inventory
- Records daily, routine activities
- Serves supervisory level of management



	TYPE OF TPS SYSTEM				
	Sales/ marketing systems	Manufacturing/ production systems	Finance/ accounting systems	Human resources systems	Other types (e.g., university)
Major functions of system	Sales management	Scheduling	Budgeting	Personnel records	Admissions
	Market research	Purchasing	General ledger	Benefits	Grade records
	Promotion	Shipping/receiving	Billing	Compensation	Course records
	Pricing	Engineering	Cost accounting	Labor relations	Alumni
	New products	Operations		Training	
Major application systems	Sales order information system	Materials resource planning systems	General ledger	Payroll	Registration system
	Market research system	Purchase order control systems	Accounts receivable/payable	Employee records	Student transcript system
	Pricing system	Engineering systems	Budgeting	Benefit systems	Curriculum class control systems
		Quality control systems	Funds management systems	Career path systems	Alumni benefactor system

Management Information Systems (MIS)

- A management information system (MIS) is an information system application that provides for management-oriented reporting. These reports are usually generated on a predetermined schedule and appear in a prearranged format.
- **Management information system**, or **MIS**, broadly refers to a computer-based **system** that provides **managers** with the tools to organize, evaluate and efficiently **manage**departments within an organization.
- *Information systems at the management level of organization that serve the functions of planning, controlling, and decision making by providing routine summary and exception reports.*

- MIS convert data from internal and external sources into information for managers.
- The source of data for an MIS usually comes from numerous databases. These databases are usually the data storage for Data Processing Systems.
- MIS summarise and report on the organisation's basic operations.
- MIS produce reports for managers interested in historic trends on a regular basis.
  - MIS operate at the tactical level
  - *Example: Annual budgeting*

Properties of MIS

- **Management-oriented:** The basic objective of MIS is to provide information support to the management in the organization for decision making.
- **Management directed:** When MIS is management-oriented, it should be directed by the management because it is the management who tells their needs and requirements more effectively than anybody else.
- **Integrated:** It means a comprehensive or complete view of all the subsystems in the organization of a company.
- **Common database:** This is the basic feature of MIS to achieve the objective of using MIS in business organizations.

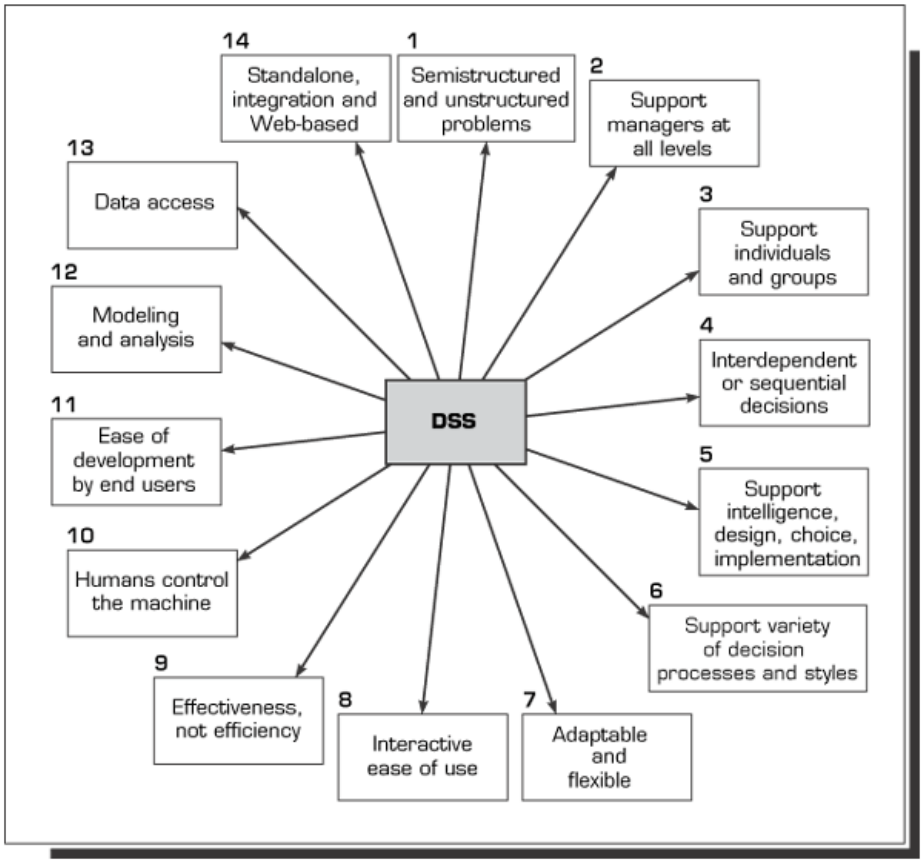
- **Computerized:** MIS can be used without a computer. But the use of computers increases the effectiveness and the efficiency of the system.
- **User friendly/Flexibility:** An MIS should be flexible.
- **Information as a resource:** Information is the major ingredient of any MIS.
- **Common data flows:** The integration of different subsystems will lead to a common data flow which will further help in avoiding duplicacy and redundancy in data collection, storage and processing.
- **Heavy planning-element:** The preparation of MIS is not a one or two day exercise. It usually takes 3 to 5 years and sometimes a much longer period.

Decision Support System(DSS)

- A decision support system (DSS) is an information system application that provides its users with decision-oriented information whenever a decision-making situation arises. When applied to executive managers, these systems are sometimes called executive information systems (EIS).
  - A Decision Support System (DSS) is an interactive computer-based system or subsystem intended to help decision makers use communications technologies, data, documents, knowledge and/or models to identify and solve problems, complete decision process tasks, and make decisions.
  - Decision Support System is a general term for any computer application that enhances a person or group's ability to make decisions.
  - Also, Decision Support Systems refers to an academic field of research that involves designing and studying Decision Support Systems in their context of Use

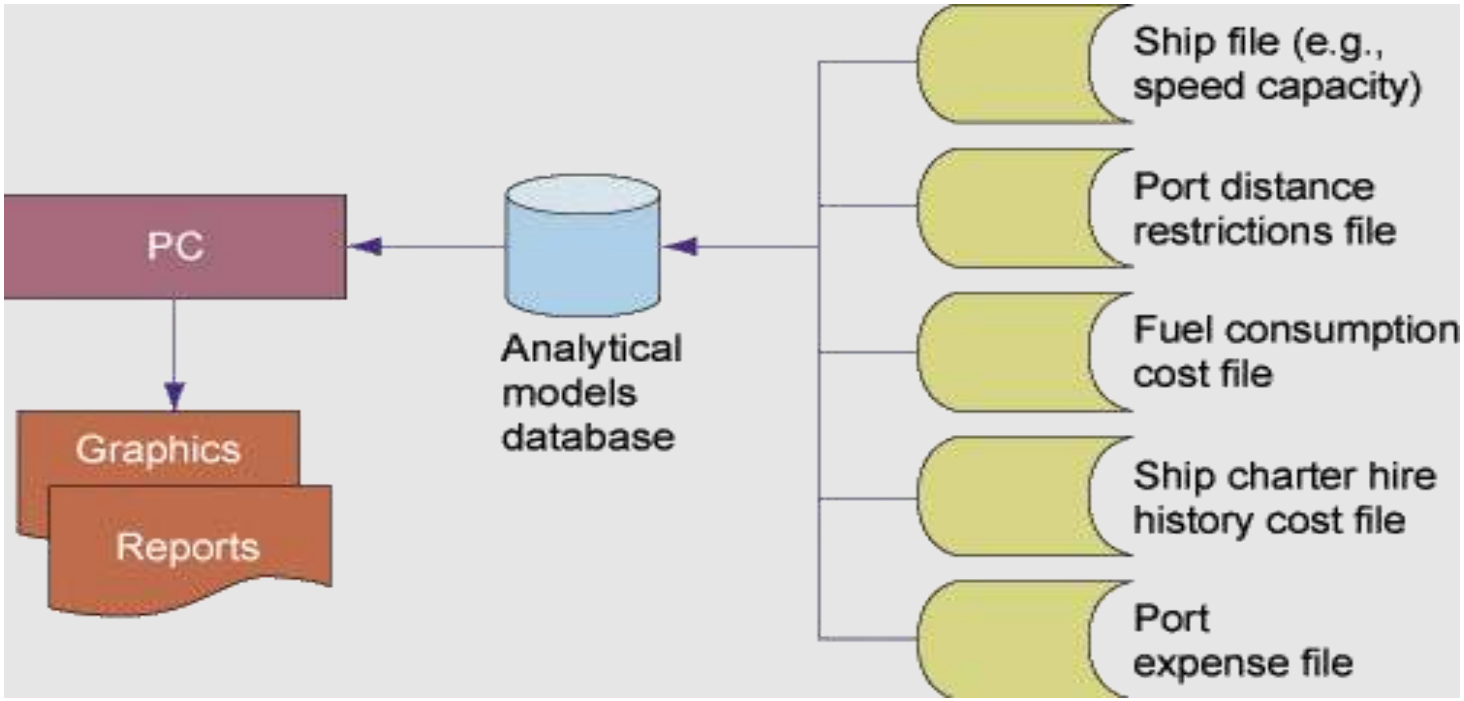
Characteristics of DSS

Figure 3.2 Key Characteristics and Capabilities of DSS



DSS:

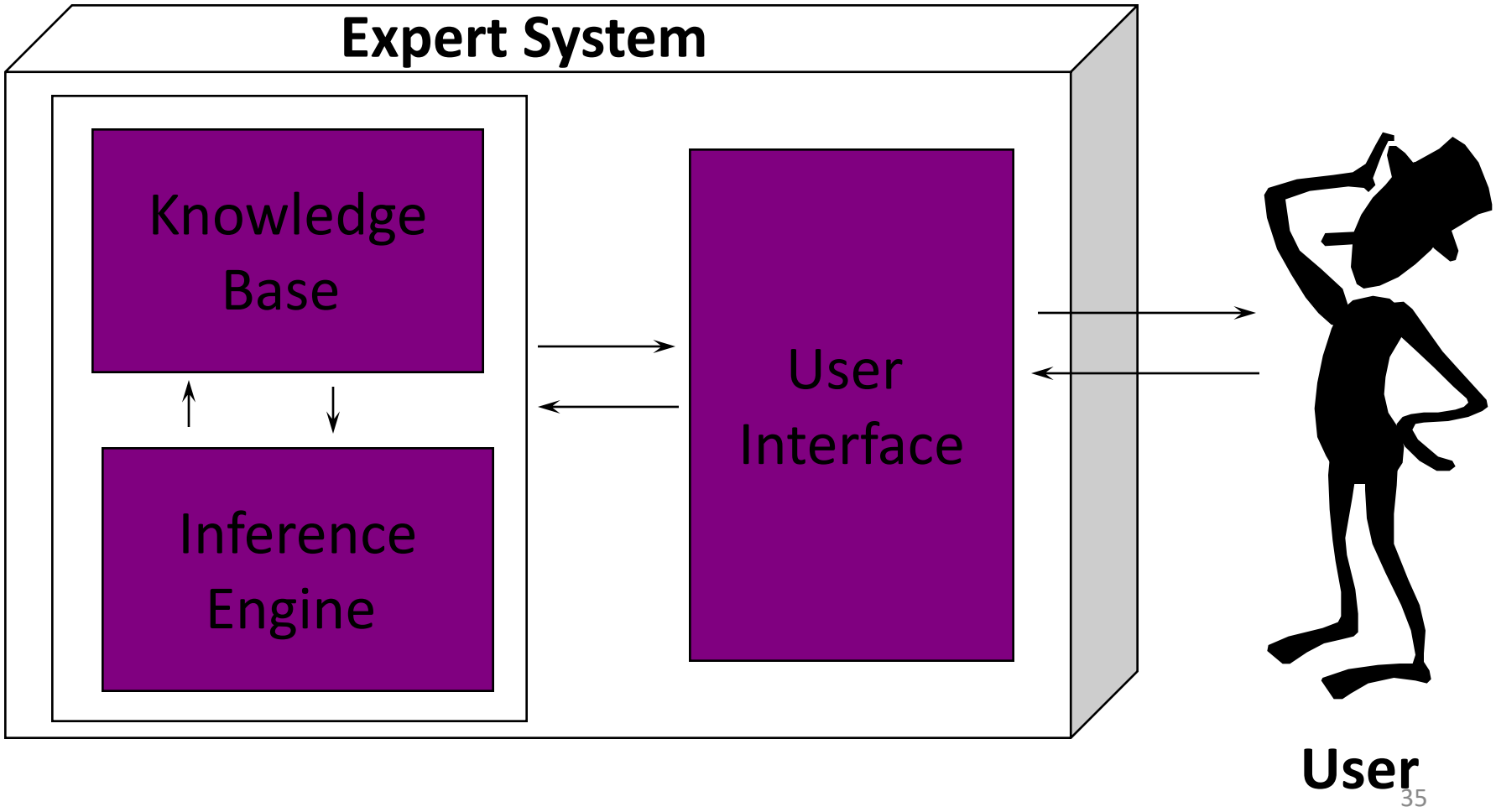
Information systems at the ***management level*** of an organization that ***combine data and sophisticated analytical models*** *to support non-routine decision making*



Expert System

- An expert system is a system that employs human knowledge captured in a computer to solve problems that ordinarily require human expertise.(Turban)
- An expert system is a computer program that tries to emulate human reasoning. It does this by combining the knowledge of human experts and then, following a set of rules, draws inferences.
- An expert system is made up of three parts:
  - A **knowledge base** stores all of the facts, rules and information needed to represent the knowledge of the expert.
  - An **inference engine** interprets the rules and facts to find solutions to user queries.
  - A **user interface** allows new knowledge to be entered and the system queried.

Components of an Expert System



Advantages

- Capture of scarce expertise
- Superior problem solving
- Reliability
- Work with incomplete information
- Transfer of knowledge

Office automation systems

- Office automation (OA) systems support the wide range of business office activities that provide for improved work flow and communications between workers, regardless of whether or not those workers are located in the same office.
- **Personal information systems** are those designed to meet the needs of a single user. They are designed to boost an individual's productivity.
- **Work group information systems** are those designed to meet the needs of a work group. They are designed to boost the group's productivity.

TABLE 1-3 Systems Development for Different IS Types

IS Type	IS Characteristics	Systems Development Methods
Transaction processing system	High-volume, data capture focus; goal is efficiency of data movement and processing and interfacing different TPSs	Process-orientation; concern with capturing, validating, and storing data and with moving data between each required step
Management information system	Draws on diverse yet predictable data resources to aggregate and summarize data; may involve forecasting future data from historical trends and business knowledge	Data-orientation; concern with understanding relationships between data so data can be accessed and summarized in a variety of ways; builds a model of data that supports a variety of uses
Decision support system	Provides guidance in identifying problems, finding and evaluating alternative solutions, and selecting or comparing alternatives; potentially involves groups of decision makers; often involves semi-structured problems and the need to access data at different levels of detail	Data- and decision logic-orientations; design of user dialogue; group communication may also be key and access to unpredictable data may be necessary; nature of systems require iterative development and almost constant updating
Expert system	Provides expert advice by asking users a sequence of questions dependent on prior answers that lead to a conclusion or recommendation	A specialized decision logic-orientation in which knowledge is elicited from experts and described by rules or other forms

Developing Information Systems and the Systems Development Life Cycle

Systems development methodology:

- Most organizations find it beneficial to use a standard set of steps, called a systems development methodology, to develop and support their information systems.
- Like many processes, the development of information systems often follows a life cycle
- A standard process followed in an organization to conduct all the steps necessary to analyze, design, implement, and maintain information systems.

Systems Development Life Cycle(SDLC)

SDLC:

- **Series of steps used to manage the phases of development for an information system or**
- **The traditional methodology used to develop, maintain, and replace IS.**
- Systems Development Life Cycle (SDLC) represents a set of general categories that show the major steps, over time, of an information systems development project.

- System development life cycle is an organizational process of developing and maintaining systems.
- It helps in establishing a system project plan, because it gives overall list of processes and sub-processes required developing a system.
- The systems development life cycle (SDLC) is a common methodology for systems development in many organizations;
- It features several phases that mark the progress of the systems analysis and design effort.

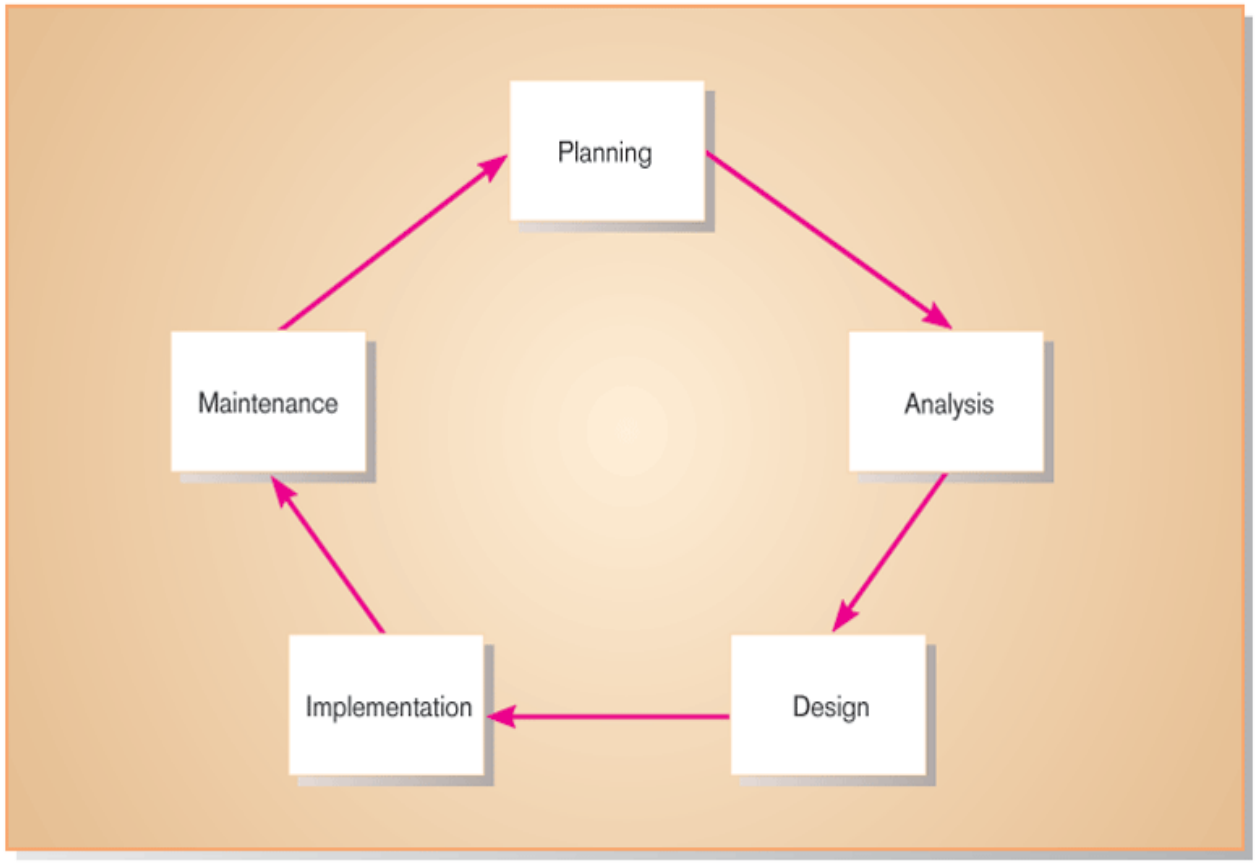
Consists of five phases:

1. **Planning**
   - **Project Identification and Selection**
   - **Project Initiation and Planning**
2. **Analysis**
3. **Design**
4. **Implementation**
5. **Maintenance**

- ***Phases are not necessarily sequential***
- ***Each phase has a specific outcome and deliverable***
- ***Individual companies use customized life cycles***

System Development Life Cycle

Figure 1-3 The systems development life cycle



- **Planning** – an organization's total information system needs are identified, analyzed, prioritized, and arranged
- **Analysis** – system requirements are studied and structured
- **Design** – a description of the recommended solution is converted into logical and then physical system specifications
- **Logical design** – all functional features of the system chosen for development in analysis are described independently of any computer platform

- **Physical design** – the logical specifications of the system from logical design are transformed into the technology-specific details from which all programming and system construction can be accomplished
- **Implementation** – the information system is coded, tested, installed and supported in the organization
- **Maintenance** – an information system is systematically repaired and improved

SDLC

TABLE 1-1 Products of SDLC Phases

Phase	Products, Outputs, or Deliverables
Planning	Priorities for systems and projects; an architecture for data, networks, and selection hardware, and information systems management are the result of associated systems
	Detailed steps, or work plan, for project
	Specification of system scope and planning and high-level system requirements or features
	Assignment of team members and other resources
	System justification or business case
Analysis	Description of current system and where problems or opportunities exist, with a general recommendation on how to fix, enhance, or replace current system
	Explanation of alternative systems and justification for chosen alternative
Design	Functional, detailed specifications of all system elements (data, processes, inputs, and outputs)
	Technical, detailed specifications of all system elements (programs, files, network, system software, etc.)
	Acquisition plan for new technology
Implementation	Code, documentation, training procedures, and support capabilities
Maintenance	New versions or releases of software with associated updates to documentation, training, and support

The Heart of the Systems Development Process

Figure 1-8 The analysis–design–code–test loop

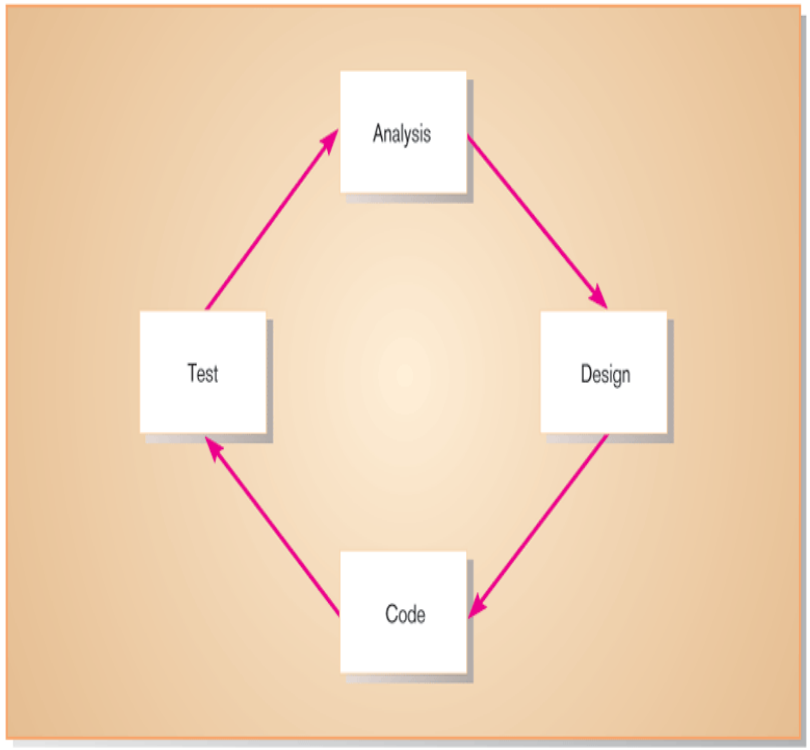
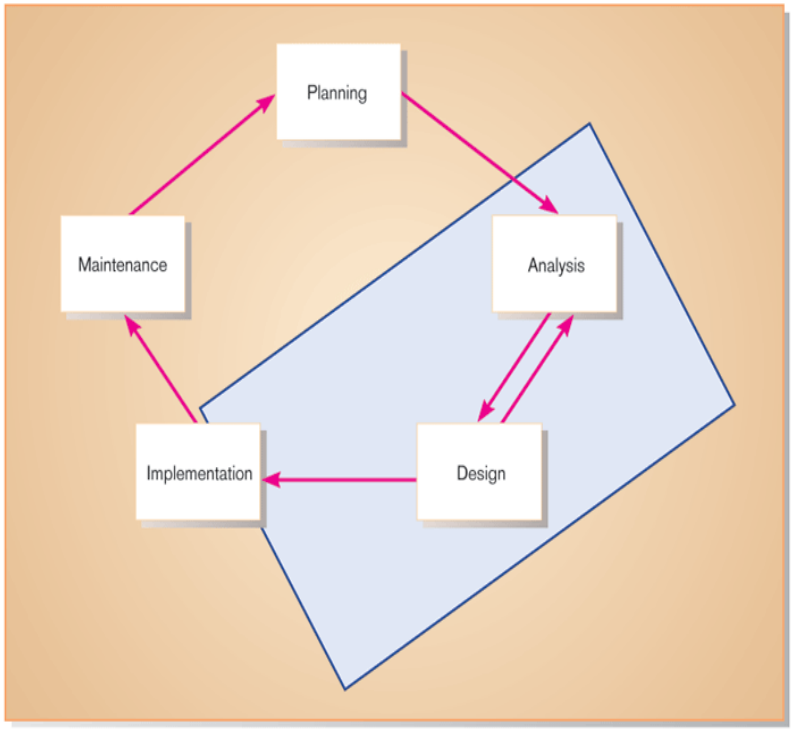


Figure 1-9 The heart of systems development



The heart of system development is analysis-design-implementation

- After collecting the system requirements, they are thoroughly analyzed by experts.
- After analyzing them properly, the design for implementation is done by keeping a stress on meeting the requirements.
- As a next step, the system design is implemented with the help of information from previous stages, so that the system meets the expected goals.

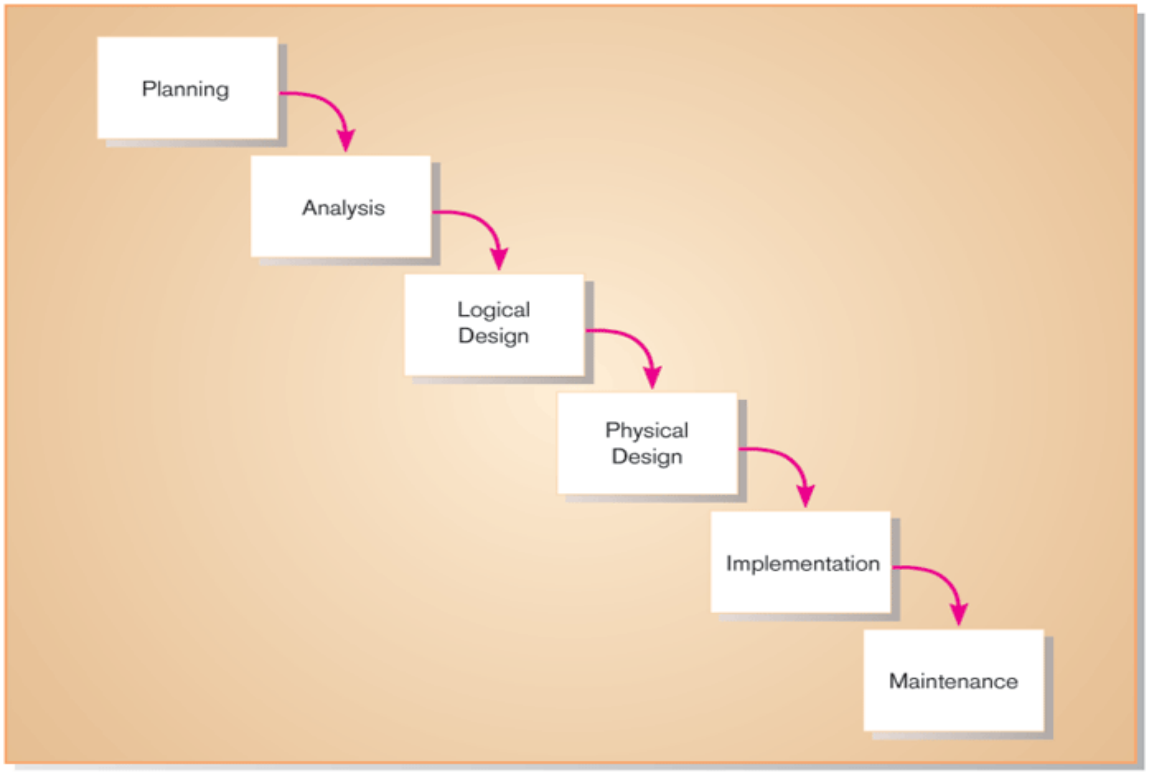
- Analysis: System Analyst gather and prioritize system requirements, ensuring a clear understanding of user needs and goals.
- Design: A detailed plan is created, outlining the system's structure, components, and interactions.
- Implementation: The system is built according to the design, involving coding,training, integration, and testing.

Waterfall Model

- The waterfall model is a linear, sequential approach to the system development life cycle (SDLC) that is popular in software engineering and product development.
- The waterfall model emphasizes a logical progression of steps.
- It was one of the earliest and most structured approaches to system/software development.
- The Waterfall model is characterized by its linear and sequential progression, where each phase must be completed before moving on to the next.

Traditional Waterfall SDLC

Figure 1-10 A traditional waterfall SDLC



One phase begins when another completes, little backtracking and looping

Waterfall model can be used when:

- Requirements are not changing frequently
- Application is not complicated and big
- Project is short
- Requirement is clear
- Environment is stable
- Technology and tools used are not dynamic and is stable
- Resources are available and trained

Problems with Waterfall Approach

- System requirements “locked in” after being determined (can't change).
- Limited user involvement (only in requirements phase).
- Too much focus on milestone deadlines of SDLC phases to the detriment of sound development practices.

Computer-Aided Software Engineering (CASE) Tools

- **Computer-aided software engineering (CASE)** refers to automated software tools used by systems analysts to develop information systems.
- These tools can be used to automate or support activities throughout the systems development process with the objective of increasing productivity and improving the overall quality of systems
- *Computer-Aided Software Engineering* (CASE) tools are automated software packages that help to automate activities in the SDLC.
- CASE tools aim to enforce an engineering-type approach to the development of software systems.
- CASE tools range from simple diagramming tools to very sophisticated programs to document and automate most of the stages in the SDLC.
  - CASE tools used since the early 1990s

- **Computer-Aided Software Engineering (CASE) tools**
  - Diagramming tools enable graphical representation.
  - Computer displays and report generators help prototype how systems "look and feel".
  - Analysis tools automatically check for consistency in diagrams, forms, and reports.
  - Central repository for integrated storage of diagrams, reports, and project management specifications.
  - Documentation generators standardize technical and user documentation.
  - Code generators enable automatic generation of programs and database code directly from design documents, diagrams, forms, and reports.

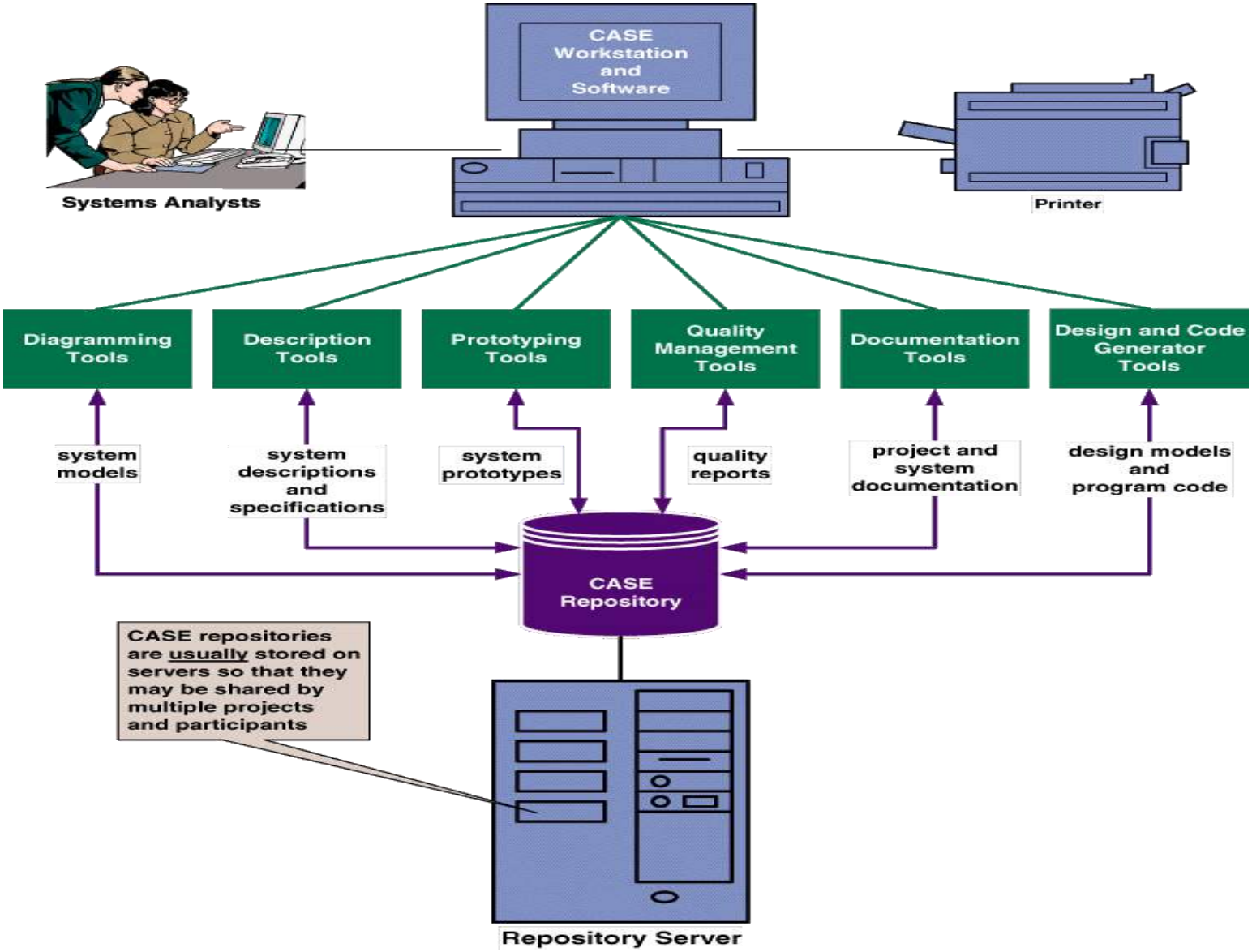
- The case for using CASE tools:
  - Improve quality of systems developed.
  - Help to increase the productivity of systems analysts.
  - Improve communication within the development team and with users.
  - Encourage an integrated approach to the SDLC.
  - Improve the management of the project.
  - Particularly helpful for systems maintenance

Types of CASE tools

There are three types of CASE tools:

- Upper CASE
  - Support analysis and design
- Lower CASE
  - Support programming and implementation
- Integrated CASE
  - Combines both upper and lower CASE

- Upper CASE tools
  - Create and modify the system design.
  - Information about the project stored in the CASE repository (reports, diagrams, files)
  - Support modelling of how the system fits into the organisation.
  - Analysis reports show incomplete parts and errors in the system design e.g. balance between process and data models.
- Lower CASE Tools
  - Generate source code and reduce need for systems programming.
  - Time for maintenance is reduced because test and debug are eliminated.
  - Once mastered, promote the re-use of existing documentation and components.


CASE Workstation and Software
Systems Analysts
Printer
Diagramming Tools
Description Tools
Prototyping Tools
Quality Management Tools
Documentation Tools
Design and Code Generator Tools
system models
system descriptions and specifications
system prototypes
quality reports
project and system documentation
design models and program code
CASE Repository
CASE repositories are usually stored on servers so that they may be shared by multiple projects and participants
Repository Server

- Examples of CASE Tools:
  - Diagramming – for representing processes, data and control structures graphically. (analysis)
  - CASE repository – holds information required to create, modify and evolve the system. (analysis, design, implementation)
  - Form and report generators – automate generation of forms and reports to aid prototyping. (design, implementation, RAD, XP)
  - Code generators – automate generation of source code from diagrams and forms. (design, implementation)
  - Project management – aid in the planning, tracking, controlling and reporting of project management. (planning)
  - Document generator – create standard reports based upon the contents of the CASE repository. (analysis, design, implementation)
  - CASE analysis tools – help to identify problems of inconsistency, redundancy, and omissions. (more likely in analysis and design)

Review Questions

1. What is information systems analysis and design?
2. How has systems analysis and design changed over the past four decades?
3. What is IS? List and explain different types of IS.
4. What are some key characteristics of a modern approach to Systems Analysis and Design
5. List and explain the different phases in the SDLC.
6. Briefly explain the central/heart stage of the system development process.
7. List and explain some of the problems with the traditional waterfall SDLC.
8. What are CASE tools?
9. Describe each major component of a comprehensive CASE system. Is any component more important than any other?
10. Describe how CASE is used to support each phase of the SDLC.

Phases of SDLC

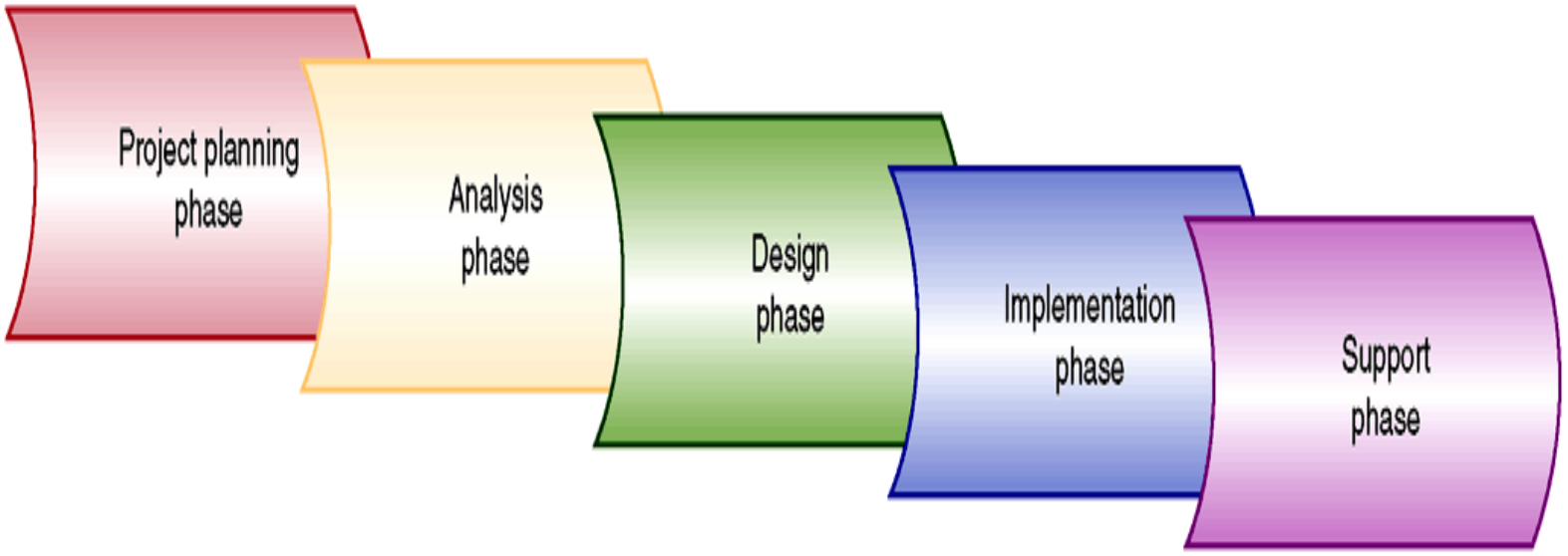


FIGURE 2-1

Information system development phases.

Phases of SDLC

- Planning: initiate, ensure feasibility, plan schedule, obtain approval for project
- Analysis: understand business needs and processing requirements
- Design: define solution system based on requirements and analysis decisions
- Implementation: construction, testing, user training, and installation of new system
- Support: keep system running and improve

Planning

- *The first phase of the SDLC in which an organization's total information system needs are analyzed and arranged, and in which a potential information systems project is identified and an argument for continuing or not continuing with the project is presented.*
- Define business problem and scope
- Produce detailed project schedule
- Confirm project feasibility
  - Economic, organizational, technical, resource, and schedule
- Staff the project (resource management)
- Launch project → official announcement

Analysis

- *Phase of the SDLC in which the current system is studied and alternative replacement systems are proposed.*
- Gather information to learn problem domain
- Define system requirements
- Build prototypes for discovery of requirements
- Prioritize requirements
- Generate and evaluate alternatives
- Review recommendations with management

Design

- *Phase of the SDLC in which the system chosen for development in systems analysis is first described independently of any computer platform (logical design) and is then transformed into technology-specific details (physical design) from which all programming and system construction can be accomplished.*
- Design and integrate the network
- Design the application architecture
- Design the user interfaces
- Design the system interfaces
- Design and integrate the database
- Prototype for design details
- Design and integrate system controls

Implementation

- ***Phase of the SDLC in which the information system is coded, tested, and installed in the organization.***
- Construct software components
- Verify and test
- Convert data
- Train users and document the system
- Install the system

Support

- *The final phase in which the information system is systematically repaired and improved*
- Maintain system
  - Small patches, repairs, and updates
- Enhance system
  - Small upgrades or enhancements to expand system capabilities
  - Larger enhancements may require separate development project
- Support users
  - Help desk and/or support team