Fundamentals of System Analysis and Design

Chapter One:

Basic Concepts in Information System Development

Topics

- System Analysis and design, System, Information systems, System thinking
- Types and Characteristics of Information Systems
- Participants in Information System Development
- Roles and qualities of System Analyst
- System development methodologies, Processes/Phase

Some basic definitions

- Systems Analysis and Design: *What is it?*
  - Systems analysis

    Process of studying an existing system to determine how it works and how it meets user needs

  - Systems design

    Process of developing a plan for an improved system, based upon the results of the systems analysis

Basic Definitions cont'd

- System analysis and design is a step by step complex method whereby computer based **information systems** that can perform basic business function are developed and maintained.
- It can also be defined as a **standard set of activities, methods, best practices, deliverables, and automated tools** that stakeholders use to develop and maintain information systems.
- System Analysis and Design is used to analyze, design and implement **improvements in the functioning of businesses** that can be accomplished through use of computerized information systems. Notice the emphasis on **business improvement**.

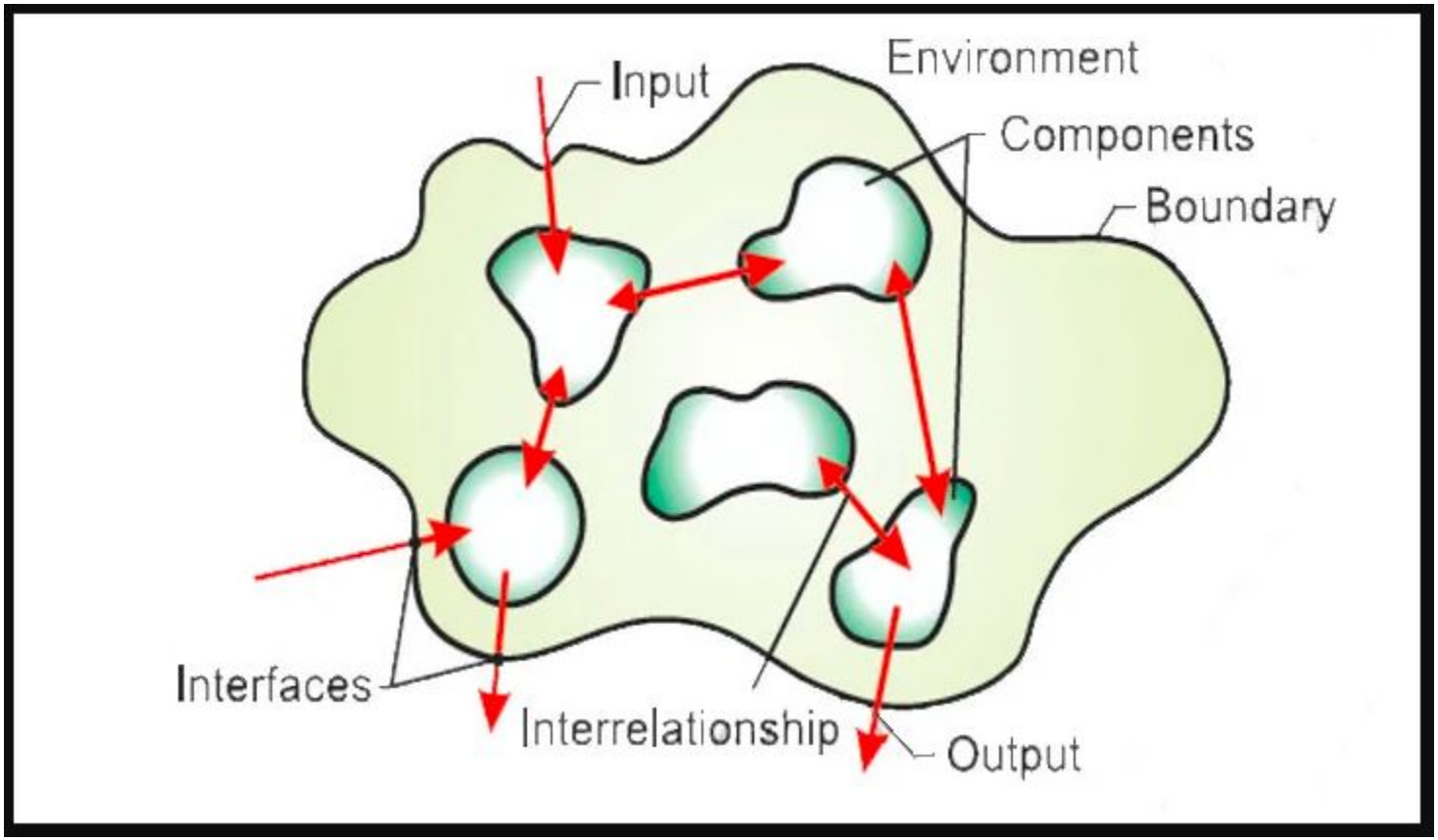
Basic Definitions cont'd

- **SAD is based on two skills/knowledge**
  - Understanding of organizations objectives, structure and process (domain Knowledge)
  - Knowledge of how to exploit information technology for the advantage of the business at hand
- **Out come of such SAD**
  - An application software (information systems) to improve users/employee efficiency by improving the business process
- *What is System in general, information system, in particular?*
  - *A system is a **core concept** defined as* an interrelated set of **components** with an **identifiable boundary**, **working together** for some **purpose**.

Basic Definitions cont'd

- **Characteristics of a system (9 characteristics used to describe systems)**
  - **Components** - either an irreducible part(the tiniest) or an aggregate of parts (subsystem)
  - **Interrelated Components-** the function of one is tied to the function of the other
  - **Boundary-** the limits of the system with in which the system is contained, and that separates it from other systems. Components within the boundary can be changed.
  - **Purpose-** The components work together to achieve some overall purpose(goal): the system's reason for existence
  - **Environment-** Everything outside the system's boundary
  - **Interfaces-** the point at which the system meets its environment
  - **Input-** What the system takes in from the environment to function
  - **Output-** The result of the function of the system
  - **Constraints-** limits to the system in terms of its capacity

Basic Definitions cont'd



Example

- Viewing a car as a system helps us determine what the problem is and fix it by breaking the system down in to its components.
- It is also important to consider the relationship one subsystem has with another in doing so.

Exercise

- Identify something as a system
- Identify and describe its characteristics (the 9 characteristics discussed)

Other Important system concepts

- **Decomposition-** being able to break down a system into its components**.** It also helps to build different parts of the system at different times or by different individuals.
- **Modularity-** relatively uniform size components or chunks.

Cont…

- **Coupling-** the extent to which subsystems are dependent on each other**.** Subsystems *should be as much independent from each other as possible*.
- **Cohesion-** the extent to which a module or a subsystem performs a single function. *When we have highly cohesive modules each module accomplishes one and only one function. This makes the module reusable in future programs*. Take a biological system as an example**.** It has highly cohesive modules**.** It is possible to transplant a heart or kidney.
- **Loosely Coupled and Highly Cohesive** systems are imperative for re-use and maintainability

Cont…

- **Systems thinking**
  - Is a mind set or way of viewing a world as a system Actually, systems thinking is just one part of the skills a systems analyst requires
  - it helps to see the big picture; it also pays to break problems down to their components to avoid complexity.
  - It minimizes the effect of a change in one module on another.
  - It emphasizes on the *relationship and the process that goes inside rather than constituent parts* or just the sum of the parts("The whole is more than the sum of its parts"). Accordingly,
    - **"A system is bigger than the sum of its components"**

Information system

- Is an arrangement of people, data, processes, communication, and information technology that interact to capture, transmit, store, retrieve, manipulate and/or display information needed 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 other users.

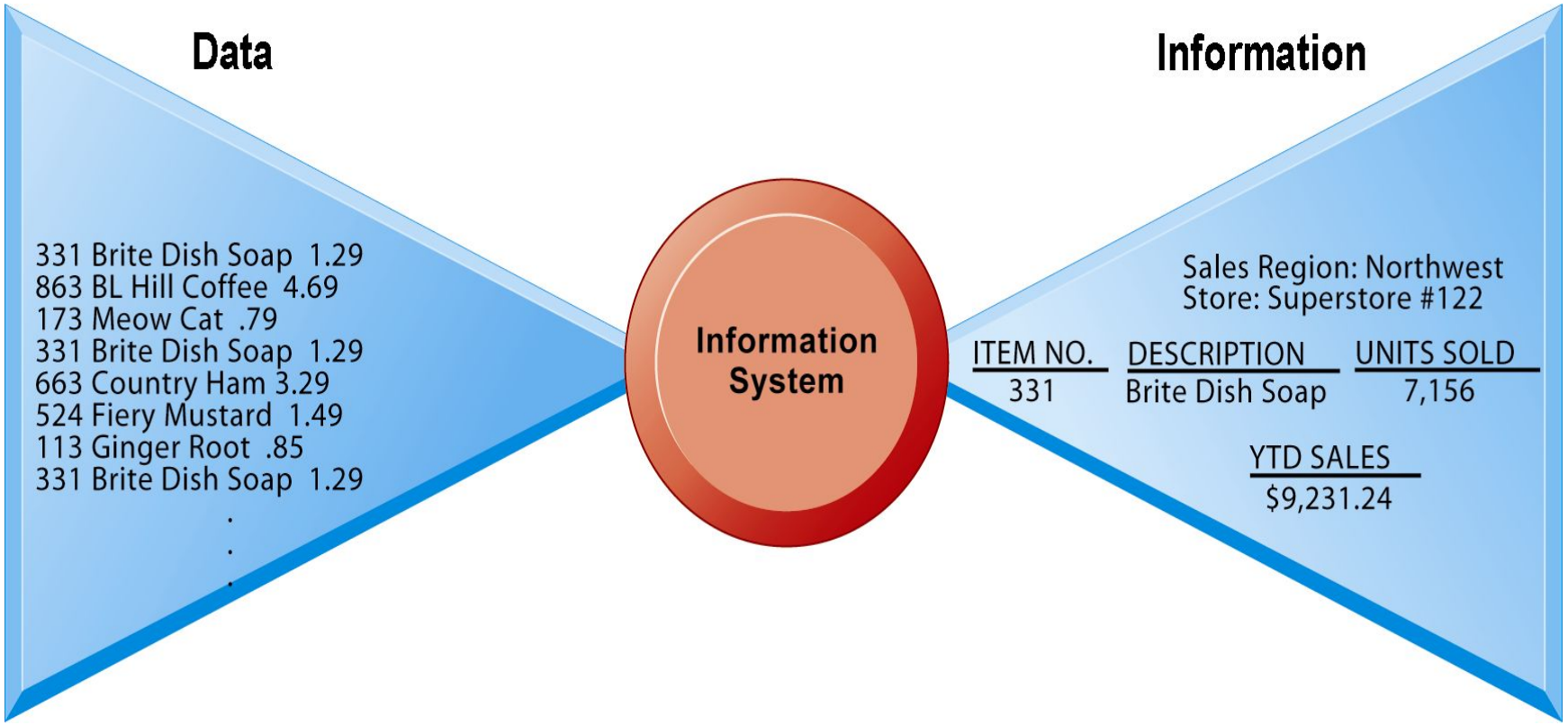
Data, Information and Knowledge

- Data
  - is a raw fact on any thing
  - It is representation real world (Objective, fragmented, and in its simplest form) eg 91, 22, 33
- Information
  - data processed, organized, or structured to provide context and relevance
  - Information is data interpreted in a way that it becomes meaningful
    - Eg. Yesterday, average temperature in Addis was 15°C.
- Knowledge
  - The application of data and information to understand concepts, relationships, and principles.
  - Knowledge is built from experience, context, and insights.
  - is more structured information in the human mind(actionable information)
  - involves interpretation, understanding, and experience and is used to make decisions or solve problems.
    - Eg: next slide

Data, Information and Knowledge

- **Example with weather forecasting scenario:**
- **Data**:
  - Monthly temperature recordings from multiple weather stations around the world (e.g., 29°C in July in Location A, 35°C in July in Location B).
- **Information**:
  - The processed data shows that average global temperatures have been steadily increasing over the past 100 years, and the frequency of extreme weather events (e.g., heat waves, hurricanes) has risen.
- **Knowledge**:
  - Based on this information, scientists conclude that human activities, particularly the burning of fossil fuels, are contributing to the rise in greenhouse gases, which in turn is leading to global warming. This knowledge is then applied to predict future climate patterns and inform policies aimed at mitigating climate change.

Data and Information



Raw data from a supermarket checkout counter can be processed and organized to produce meaningful information, such as the total unit sales of dish detergent or the total sales revenue from dish detergent for a specific store or sales territory.

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Types of information systems

- IS can be classified into various types based on their function:
  - ***TPS***
  - ***MIS***
  - ***DSS***
  - ***EIS***
  - ***ERPs***
  - ***SCM***
  - ***CRM***
  - ***KMS***

Type	Purpose	Examples	Users	Key Features
TPS	Handles and records daily transactions.	Point-of-sale systems, payroll systems	Operational staff, management	High-volume processing, real-time updates, accuracy in repetitive tasks
MIS	Provides routine reports and summaries for decision-making	Sales management, inventory control	Middle managers	Aggregates data from TPS, regular reporting, analysis
DSS	Supports complex decision-making with data analysis.	Financial planning, risk analysis	Senior managers, analysts	Interactive, "what-if" scenarios, supports semi-structured decisions
EIS	Provides high-level information for strategic decisions	Dashboards, KPI reports, trend analysis	Senior executives, top managers	Summarized, visual data, key performance metrics

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Type	Purpose	Examples	Users	Key Features
ERPs	Integrates all departments and functions into a unified system..	SAP, Oracle ERP	Entire organization	Centralized database, modular, covers all business processes
SCM	Manages the flow of goods, information, and finances in supply chains.	Inventory management, vendor management	Supply chain managers, logistics	Real-time data on inventory, orders, and performance
CRM	Manages customer interactions and relationships	Salesforce, HubSpot, Zoho CRM	Sales teams, marketing, support	Tracks customer interactions, manages leads, analyzes customer behavior
KMS	Captures and shares organizational knowledge	Intranets, SharePoint, Wikis	Employees, project teams	Centralized knowledge repository, encourages sharing and collaboration

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Other Types of IS Cont'd…

- ***Other Systems***
  - E-commerce Applications: Business to Customer, Business to Business, and Customer to Customer
  - IRS- Information retrieval systems
- **Business intelligence**
  - Class of software applications
  - Analyze current and historical data to find patterns and trends and aid decision-making
  - Used in systems that support middle and senior management
    - Data-driven DSS
    - Executive support systems (ESS)

Other Types of IS Cont'd…

- Executive support systems
  - Support senior management
  - Address non-routine decisions
    - Requiring judgment, evaluation, and insight
  - Incorporate data about external events (e.g. new tax laws or competitors) as well as summarized information from internal MIS and DSS

Cot...

- **Building blocks of IS**
  - **Data-** the raw facts used to create useful information.
  - **Processes-** the activities that carry out the mission of the business.
  - **Interfaces-** how the system interfaces(interacts) with its users and other information systems.
  - **People-** experts who design, implement, operate, and maintain the IS, ensuring it meets the organization's needs. End-users who input data, retrieve information, and use system outputs.

Participants in Information System Development

- Usually system development is a team work and project based.
- Who do you think are the stakeholders (participants) in IS design and development?
- How do each of these stakeholders participate?

Cont…

- **System owners**- pay for the system to be built and maintained.
  - They own the system, set priorities for the system, and determine policies for its use. In some cases, system owners may also be system users.
- **System users**- are the people who actually use the system to perform or support the work to be completed.
  - System users define the business requirements and performance expectations for the system to be built.

Cont…

- **System analysts**- facilitate the development of information systems and computer applications by bridging the communication gaps that exist between non-technical system owners and users and technical system designers and builders.
- **System designers**- are the technical specialists who design the system to meet users' requirements. In many cases, system designers may also be system builders.

Cont…

- **System builders** are the technical specialists who construct, test, and deliver the system into operation.
- **IT vendors and consultants** who sell hardware, software and services to businesses for incorporation into their information systems.

Systems Analyst

- Professional computer employee who performs analysis and design
- Change agent
  - Overcome reluctance of users to change
- Typical career path
  - Programmer
  - Programmer / Analyst
  - Systems Analyst

Systems Analyst
Functions

Coordination

- Schedules and system-related tasks
- Personnel
  - Manager
  - Programmers
  - Users
  - Vendors of computer equipment

Systems Analyst
Functions

Communication

- Oral presentations
- Written documentation

Planning and design

- Plans and designs new system
- Involved from beginning of project to final implementation of the system

System Analyst

Necessary skills required

- **Analytical skills**
- **Technical skills**
- **Business skills**
- **Interpersonal skills**
- **Attention to details**
- **Continuous learning**

Skills Cont'd…

- **Analytical skills**
  - **Problem Identification:** a problem is the difference between an existing situation and a desired situation. Being able to see the real problem from an organizational perspective.
  - **Problem-Solving:** diagnose systems issues, identify inefficiencies, and propose effective solutions.
    - formulating alterative solutions, choosing the best alternative, devising a plan for its implementation
  - **Requirement Gathering:** Expertise in collecting and documenting system requirements from stakeholders.
    - Organizational knowledge- how organizations work (Example a payroll system developed for a Government Unit wouldn't work for a private company)
  - **Process Mapping:** Understand business processes and model them using modeling tools (e.g., DFD, UML, flowcharts, BPMN).
  - **Systems Thinking:** see how different parts of a system interact and affect one another, anticipating impacts of changes.

Skills Cont'd…

- **Technical skills-**
  - **Understanding of IT Systems**: Strong knowledge of hardware, software, networks, and databases.
  - **Programming Knowledge**: Familiarity with programming languages (understand and write scripts (e.g., SQL, Python, Java)
  - **Data Analysis**: Ability to analyze large datasets and generate insights using data analysis tools.
  - **Database Management**: Knowledge of relational databases, SQL, and NoSQL databases for querying and managing data.
  - **Systems Design**: Skills in designing systems architecture, data models, and workflows.
  - **Knowledge of Software Development Life Cycle (SDLC)**: Understand methodologies such as Agile, Waterfall, for system development.
  - **Knowledge of Operating Systems**: Proficiency in various operating systems (e.g., Windows, Linux) to evaluate and implement solutions.
  - **Cloud Computing**: Familiarity with cloud platforms (AWS, Azure) for system deployment and integration.
  - **Cybersecurity Awareness**: Understanding of security protocols and risks to ensure systems are secure.

Skills Cont'd…

- **Business skills**
  - **Business Acumen**: Knowledge of industry-specific business processes, objectives, and challenges.
  - **Project Management**: Ability to manage projects, work within timelines, and meet budgets, often working with project management tools like Jira or MS Project.
  - **Cost-Benefit Analysis**: Ability to evaluate the financial implications of system changes and implementations.
  - **Risk Management:** identifying risk in an IS development process and minimizing it. For instance, use of standard or commonly used technology will be less risky.
  - **Change management:** helps people make a smooth transition from one information system to another
  - **Vendor Management**: Skills in working with third-party vendors for system implementations and support.

Skills Cont'd…

- **Interpersonal skills**
  - **Communication:** Strong verbal and written communication skills to bridge concept understanding gap between technical experts and non-technical stakeholders
    - Develop interviewing, listening, written and oral presentation skills
  - **Collaboration**: Ability to work with cross-functional teams, including developers, project managers, and business stakeholders.
    - Working in a team (team player),
    - facilitating groups-guiding groups to work together
  - **Negotiation**: Skills to negotiate system requirements and project scope with various stakeholders.
    - Managing expectations- educate pessimists
    - Managing setbacks- handling difficult situations/conflicts/disagreements
  - **Adaptability**: Ability to manage change and adapt to shifting business priorities.

Skills Cont'd…

- **Attention to details**
  - **Documentation**: Ability to thoroughly document system requirements, processes, and configurations.
  - **Quality Assurance**: Skill in testing systems to ensure they meet the required specifications and function as expected.
- **Continuous learning**
  - **Keeping Up with Technology Trends:** Staying updated with new technologies, methodologies, and industry best practices to remain effective.

Approaches to Systems Development

- **Process-Oriented Approach**
  - the primary focus is on the **business processes** that the system must support.
    - **Emphasis**: the **workflow, actions, and procedures** required to complete tasks or deliver services.
    - **Modeling**: involves use of flowcharts, process diagrams (e.g., Business Process Model and Notation, or BPMN), and Data Flow Diagrams (DFDs) to represent and model business processes.
    - **Functionality-Centric**: The system's functionality is prioritized, ensuring that the processes are performed efficiently.
    - **Hierarchical Structure**: Often, processes are broken down into sub-processes and tasks in a **top-down** manner.
    - **Clear Sequence of Steps**: The sequence of actions and the flow of information between processes is a key concern

Approaches to Systems Development…

- **Process-Oriented Approach cont'd**
  - Well-suited for organizations where workflows are clearly defined and process efficiency is a priority.
  - Provides a clear understanding of how different parts of a system interact.
  - Helps to identify bottlenecks and inefficiencies in processes that can be optimized through automation.
  - May overlook or undervalue the importance of data structure and relationships.
  - Not as adaptable if business processes change frequently, requiring re-analysis and re-design of processes.

Approaches to Systems Development…

- **Common Methodologies for Process-Oriented Approach**
  - **Business Process Reengineering (BPR)**: A process improvement approach that focuses on redesigning business workflows for better performance.
  - **Structured Systems Analysis and Design Method (SSADM)**: Focuses on understanding the data flows and processes within a system but emphasizes processes as the key driver.
  - **Event-Driven Process Chain (EPC)**: A method for modeling business processes in enterprise resource planning (ERP) systems.
  - **Example Use Case:** A **customer service system** where the focus is on improving the workflow of handling service requests, assigning them to support agents, and resolving issues within a certain time frame

Approaches to Systems Development…

- **Data-Oriented Approach**
  - the focus is on the **data**—how it is structured, stored, and related—within the system.
  - Emphasis: organization of data, integrity, and management of data across the system, independent of the processes that manipulate that data.
    - Business rules depict how an organization captures and processes data
  - Data Structure: system is designed around the data being stored, its attributes, relationships, and constraints
  - Modeling: Techniques like Entity-Relationship Diagrams (ERDs) or Class Diagrams are used to model the data entities and their relationships.

Approaches to Systems Development…

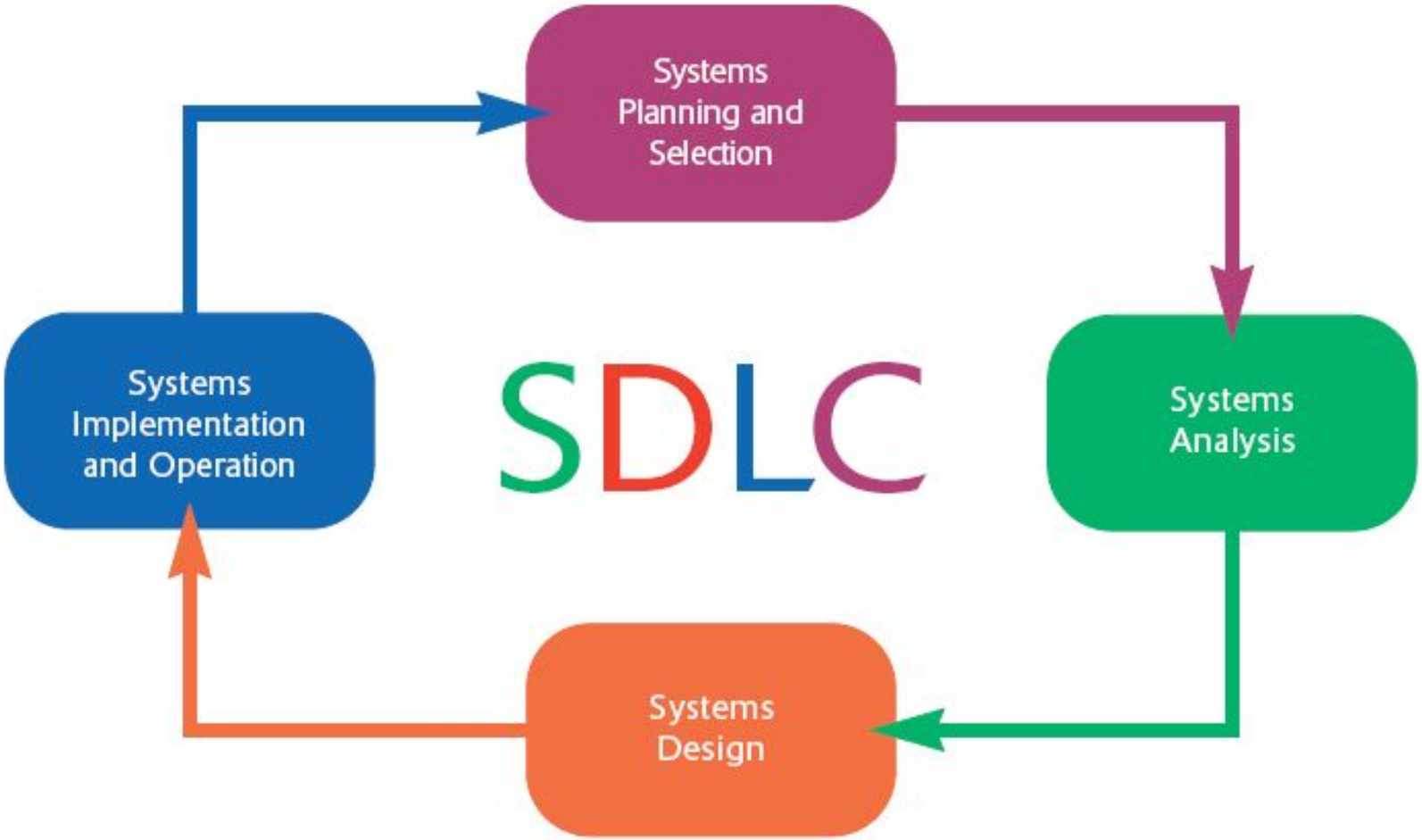
- **Data-Oriented Approach cont'd**
  - Data Integrity and Consistency: Ensuring that data is accurate, reliable, and consistent across the system is a primary concern.
  - Data Independence: The system separates the data model from the processes that use the data.
    - Changes to processes don't require re-structuring the data.
  - Normalization: Data is structured in such a way that redundancy is minimized, and relationships are clearly defined through keys and constraints.

Key differences between Process Oriented and Data Oriented approaches to system Dev't

Characteristic	Process Orientation	Data Orientation
System focus	What the system is supposed to do and when	Data the system needs to operate
Design stability	Limited, because business processes and the applications that support them change constantly	More enduring, because the data needs of an organization do not change rapidly
Data organization	Data files designed for each individual application	Data files designed for the enterprise
State of the data	Much uncontrolled duplication	Limited, controlled duplication

System Development Approaches, Methodologies and Phases/Processes

- Organizations use a standard set of steps, called a **systems development methodology,** to develop and support their information systems.
- The **systems development life cycle (SDLC)** is a common, four-step methodology for systems development in many organizations that marks the phases or steps of information systems development


Systems
Planning and
Selection
Systems
Analysis
Systems
Design
Systems
Implementation
and Operation
SDLC

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Phase 1: Systems Planning and Selection

- The primary activities of this phase are:
  - identifying the need for a new or enhanced system and
  - Selection of projects that are perceived to meet the objectives of an organization
- Information system needs of an organization may result from:
  - Requests to deal with **problems** in current procedures
  - The desire to perform additional tasks (or **compliance to standards**)
  - The realization that information technology could be used to capitalize on an existing **opportunity**

Systems Planning and Selection

- Once a project is selected a plan is designed that lays out important issues such as:
  - *Feasibility study*
  - *Scope*
  - *Schedule*
- The plan is finally presented to the management to proceed to the next phase.

Phase 2: Systems Analysis

- During this phase, the analyst thoroughly studies the organization's current procedures and the information systems used to perform different tasks.
- The activities generally included in the analysis phase are:
  - determining the requirements of the system
  - Requirement structuring and elimination of redundancies
  - generating alternative initial designs to match the requirements
- The output of the analysis phase is a description of the **alternative solution recommended by the analysis team**

Phase 3: Systems Design

- During systems design, analysts convert the description of the recommended alternative solution into logical and then physical system specifications.
- Logical design is not tied to any specific hardware and systems software platform.
- During physical design decision is made regarding:
  - programming language
  - database systems
  - hardware platform
  - operating system, and
  - network environment the system will run under.
- The final product of the design phase is **the physical system specifications**

Phase 4: Systems Implementation and Operation

- During systems implementation and operation, you turn system specifications into a working system that is tested and then put into use.(a system in production, a deployed system)
- Implementation includes coding, testing, and installation.
- During the operation stage, programmers make the changes that users ask for and modify the system to reflect changing business conditions.

IS Development Methods

- **The Most prominent methodologies for modeling and designing systems:**
  1. **Structured methodologies**
  2. **Object-oriented development**
  3. **Agile/Adaptive Methods**
- **Structured methodologies**
  - **Structured: Techniques are step-by-step, progressive**
  - **Process-oriented: Focusing on modeling processes** or actions that manipulate data
  - **Separate data from processes**

Development Methods Cont'd…

- **Object is basic unit of systems analysis and design**
  - Object:
    - Combines data and the processes that operate on those data
    - Data encapsulated in object can be accessed and modified only by operations, or methods, associated with that object
- **Object-oriented modeling based on concepts of class and inheritance**
  - Objects belong to a certain class and have features of that class
  - May inherit structures and behaviors of a more general, ancestor class

OO vs Structured Methods

- **More iterative and incremental than traditional structured development**
  - **Systems analysis: Interactions between system and users analyzed to identify objects**
  - **Design phase: Describes how objects will behave and interact; grouped into classes, subclasses and hierarchies**
  - **Implementation: Some classes may be reused from existing library of classes, others created or inherited**
- **Because objects are reusable, object-oriented development can potentially reduce time and cost of development**

Alternative approaches to development

- Prototyping
- joint application design (JAD)
- rapid application development (RAD)
- participatory design (PD)
- Agile Methodologies

Prototyping

- **Prototyping** is the process of designing and building a scaled-down but working version of a desired system
- The key advantages of the prototyping technique are:
  - it involves the user in analysis and design
  - it captures requirements in concrete, rather than verbal or abstract form

Joint Application Design

- **joint application design (JAD)** is a process the purpose of which is to structure the requirements determination phase of the analysis and the reviews that occur as part of the design
- Users, managers, and systems developers are brought together for a series of intensive structured meetings run by a JAD session leader

Rapid Application Development

- **Rapid application development (RAD)** is a Systems development methodology created to radically decrease the time needed to design and implement information systems.
- Focus is more on system functionality and user interface requirements at the expense of detailed business analysis and concern for system performance issues

Participatory Design

- **Participatory design (PD)** emphasizes the role of the user much more than traditional techniques do, such as structured analysis and structured design
- Each user has an equal voice in determining system requirements and in approving system design

Agile Methodologies

- **Agile Methodologies** a family of development methodologies characterized by
  - short iterative cycles and extensive testing
  - active involvement of users for establishing, prioritizing, and verifying requirements and
  - a focus on small *teams of talented, experienced programmers*.
    - Teams usually are focused and may include SME, Requirements Engineers, Developers(Programmers)

Computer-Aided Software Engineering (CASE) Tools

- **Computer-aided software engineering (CASE)** refers to automated software tools used by systems analysts to develop information systems.
- The general types of CASE tools include:
  - Diagramming tools
  - Computer display and report generators
  - Documentation generators
  - Code generators

Benefits of Systems Analysis and Design

- Better alignment of the system with business needs
  - Understanding requirements
  - Minimizing mismatch: proper analysis helps to avoid building unnecessary features, this avoids redesign cost
- Improved system quality and reliability
  - Detailed analysis to identify issues and address them at design level leads to fewer bugs during post implementation maintenance
  - Rigorous testing of individual components and the system as a whole ensures better reliability
  - Analyzing both functional and non-functional requirements results in a robust system that can handle real world challenges

Benefits…

- Creates an opportunity to optimize resource (cost and time) by identifying problems early
  - By investing time in the analysis phase, potential challenges are identified early preventing costly revisions later
  - Leads to fewer surprises during development, keeping the project on budget and on time
  - Well documented requirements and structured design prevents scope creep, reduces unnecessary rework and keeps development time in check
  - Clear plans for the system's architecture and work flow enables the team to allocate resources (time, people, technology) more efficiently

Benefits…

- Clear communication between stakeholders and developers
  - SAD encourages use of visual tools such as data flow diagram (DFD) and Entity relationship diagrams (ERD) to communicate systems requirements and processes; such tools help to bridge the gap between non-technical stakeholders and technical developers
  - Regular feedback loops ensure alignment of expectations and any discrepancies are addressed promptly

Benefits…

- Scalability and Flexibility
  - Systems are often designed in a modular way, allowing future expansion and improvement without having to rework the entire system
  - A well designed system is easy to upgrade and to maintain
- Enhance user experience
  - SAD involves user centric design
- Improved documentation and training
  - SAD produces extensive documentation that serves as a valuable reference for developers and users
  - Well designed systems are easier to explain and train

End of Chapter Questions

1. How would you define a system in your own words? Can you give an example of a system (with 9 characteristics) you interact with daily?
2. How would you explain systems thinking to someone unfamiliar with it?
3. If a company is struggling with disconnected HR management, procurement processes, and other processes what type of information system would you recommend to integrate these functions and improve overall efficiency? Why?
4. How do the data-oriented and process-oriented approaches differ? Can you explain how each approach connects to both structured and object-oriented development methods?
5. Explain at least two alternative approaches to IS development?

End of Chapter One