System Analysis and Design (SAD)
Unit 1

What is System Analysis and Design (SAD)?

System Analysis and Design (SAD) is the **process of understanding, examining, designing, and implementing an information system** that meets an organization's specific needs. It plays a crucial role in software development, business process optimization, and IT system implementation.

SAD helps in:

Understanding business requirements and defining system objectives.

- **Identifying problems** in an existing system and proposing solutions.
- **Designing structured models** for software or business process automation.
- **Ensuring system reliability, scalability, and user-friendliness**.

SAD is widely used in industries such as **banking, healthcare, e-commerce, manufacturing, and education** to develop efficient systems that improve operations.

Why is SAD Important?

- **Enhances Efficiency:** Streamlines business operations through automation.
- **Improves Decision Making:** Provides structured data and insights for better management.
- **Ensures User Satisfaction:** Designs user-friendly systems with optimal functionality.
- **Reduces Costs & Errors:** Automates processes to eliminate manual errors and save resources.
- **Future-Proofing:** Develops scalable systems that adapt to changing requirements.

What is a System:

A **system** is a **set of interrelated components** that work together to achieve a common goal. It takes **input**, processes it, and produces **output**. Systems can be **manual or automated**, simple or complex.

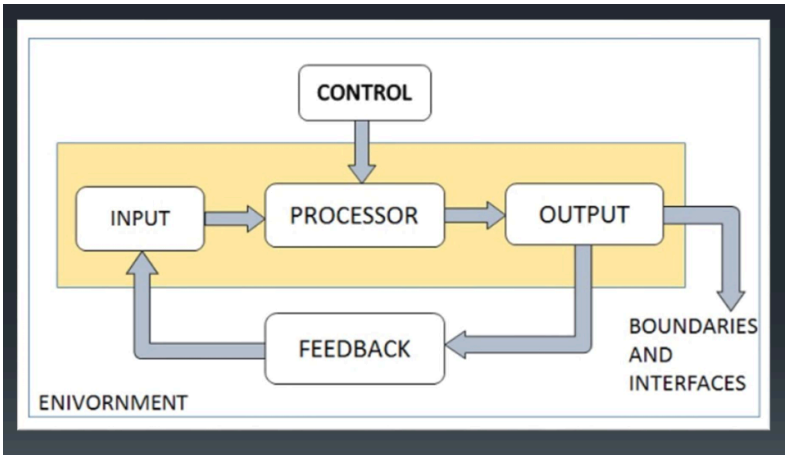
Key Characteristics of a System:

1. **Components** – A system consists of multiple elements (subsystems).
2. **Interconnectivity** – The components interact with each other.
3. **Boundary** – The system has a defined scope and limits.
4. **Input and Output** – The system processes input and generates output.

5. **Feedback Mechanism** – Helps maintain system efficiency and improve performance.

Elements of a System:

- Input and Output – The system processes input and generates output.
- Processor - The processor is the element of a system that involves the actual transformation of input into output.
- Control - The control element guides the system. It is the decision making subsystem that controls the pattern of activities governing input, processing, and output.
- Feedback – Helps maintain system efficiency and improve performance.
- Boundary – The system has a defined scope and limits.
- Interconnectivity – The components interact with each other.



Properties of a System

- **Organization** - Organization implies structure and order. It is the arrangement of components that helps to achieve predetermined objectives.
- **Interaction** - It is defined by the manner in which the components operate with each other.
- **Interdependence** - It means how the components of a system depend on one another. For proper functioning, the components are coordinated and linked together according to a specified plan. The output of one subsystem is required by the other subsystem as input.
- **Integration** - It is concerned with how system components are connected together. It means that the parts of the system work together within the system even if each part performs a unique function.
- **Central Objective** - The objective of the system must be central. It may be real or stated. It is not uncommon for an organization to state an objective and operate to achieve another.

Types of Systems with Examples

1. Natural System

A system that exists in nature without human intervention.

Example:

- **Solar System** – The sun, planets, and other celestial bodies form a natural system that follows gravitational laws.
- **Human Body** – Different organs (heart, lungs, brain) work together to sustain life.

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2. Man-Made System

A system designed and created by humans to fulfill specific purposes.

Example:

- **Traffic Management System** – Traffic lights, sensors, and monitoring cameras work together to regulate traffic flow.
- **Banking System** – ATMs, online banking, and financial records ensure smooth financial transactions.

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3. Open System vs. Closed System

Open System

An open system interacts with its environment and exchanges information, energy, or resources.

Example:

- **A University** – It interacts with students, faculty, and industries for education and research.

Closed System

A closed system does not interact with the external environment.

Example:

- **Chemical Reaction in a Closed Flask** – No exchange of material with the surroundings.

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4. Physical System vs. Abstract System

Physical System

A tangible system that can be seen and touched.

Example:

- **Computer System** – CPU, monitor, keyboard, and mouse work together to process data.

Abstract System

A conceptual system that exists as an idea or model.
Example:

- **Economic System** – Includes concepts like supply, demand, and market forces.

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5. Information System

An automated system that collects, processes, stores, and distributes information.

Example:

- **Library Management System** – Tracks book availability, borrowing history, and overdue fines.
- **Hospital Management System** – Manages patient records, appointments, and billing.

Real-Life Example of a System: Online Shopping System

An **e-commerce platform** like Amazon is a system consisting of:

- **Input:** User searches for a product.
- **Processing:** The system retrieves product details from the database.
- **Output:** The user sees product recommendations and purchase options.
- **Feedback:** Customer reviews improve product recommendations.

A **system** is a structured arrangement of components working together to achieve a goal. It can be natural or man-made, open or closed, and physical or abstract. Understanding systems helps in designing efficient business processes, software applications, and technological solutions.

Classification of Systems –

Systems are classified based on their structure, interaction, and functionality.

Based on Interaction with the Environment

Open System

- Interacts with the external environment and adapts based on inputs.
- Example: A university receives students, provides education, and sends graduates into the workforce.

Closed System

- Works independently, with minimal interaction with the environment.
- Example: A wristwatch operates without external input, keeping time automatically.

Based on Human Involvement

Manual System

- Requires human effort to operate.
- Example: A traditional library system where books are issued and returned manually by the librarian.

Automated System

- Uses technology to operate without human intervention.
- Example: ATMs dispense cash based on user input, reducing manual work Components of System Analysis and Design

Based on Processing Mode

Batch Processing System

- Processes large amounts of data in batches at scheduled times.

- Example: Payroll systems process salary payments at the end of the month.

Real-Time System

- Processes data instantly as events occur.
- Example: Air traffic control systems track aircraft positions in real-time.

Real-Time Systems

A real-time system processes information instantaneously, without delays.

Types of Real-Time Systems

1. **Hard Real-Time System** – No delays are allowed; failure can be catastrophic.
    - Example: Pacemaker, which controls heart rhythms.
2. **Soft Real-Time System** – Some delays are tolerable but should be minimized.
    - Example: Online video streaming, where occasional buffering is acceptable.

Distributed Systems

A distributed system consists of multiple computers working together as a single system.

Characteristics

- **Scalability** – Handles growing workloads.
- **Fault Tolerance** – Continues working even if some parts fail.
- **Resource Sharing** – Uses multiple systems to distribute tasks.

Example: Cloud Computing

- **Google Drive** stores user data across multiple servers worldwide, ensuring fast access and backup.

What is Design?

Design is the process of creating a plan, structure, or solution to achieve a specific goal. It involves defining how different components will work together to form a functional, efficient, and aesthetically pleasing system, product, or process.

Key Characteristics of Design

- **Purposeful** – Every design has a goal or function.
- **Systematic** – It follows a structured approach.
- **User-Centered** – It focuses on ease of use and efficiency.
- **Creative & Analytical** – Combines innovation with logical thinking.

Types of Design with Examples

1. System Design

Defines how different components of a system will work together.

Example:

- **Banking System Design** – Includes customer login, transaction processing, and security features.

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2. Software Design

Focuses on defining the architecture, components, and interfaces of a software application.

Example:

- **E-commerce Website Design** – Includes product pages, shopping cart, payment gateway, and user accounts.

3. Product Design

Creates physical or digital products that meet user needs.

Example:

- **Smartphone Design** – Defines screen size, button layout, and user interface.

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4. Architectural Design

Involves designing buildings and infrastructure.

Example:

- **House Design** – Includes the layout of rooms, windows, and ventilation.

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5. UI/UX Design

Focuses on creating user-friendly digital interfaces.

Example:

- **Mobile App Design** – Ensures easy navigation, attractive visuals, and smooth functionality.

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6. Engineering Design

Applies scientific principles to create machines, structures, or processes.

Example:

- **Bridge Design** – Ensures strength, durability, and traffic capacity.

Real-Life Example of Design: Car Design

- A car's design involves:
  - ✔ **Exterior Design** – Shape, color, aerodynamics.
  - ✔ **Interior Design** – Seating, dashboard layout.
  - ✔ **Mechanical Design** – Engine, fuel system, brakes.
  - ✔ **Software Design** – GPS navigation, smart sensors.

Design is a structured approach to problem-solving, ensuring functionality, efficiency, and user satisfaction. It applies to systems, software, products, buildings, and user interfaces.

Why is System Design Important?

System design is a crucial phase in the development of any information system, software, or product. It provides a detailed blueprint for building and implementing the system, ensuring that it meets the specified requirements and functions effectively. Here's why system design is so important:

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1. Clear Structure and Blueprint

System design translates the **requirements** gathered during the analysis phase into a **clear, actionable structure**. It provides a detailed map that guides the development team and ensures all components of the system interact in the right way.

Example:
In a **hospital management system**, the design will specify how different modules (patient records, appointments, billing) will interact and integrate. Without design, developers would lack a clear understanding of how to build the system, leading to confusion and inefficiency.

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2. Ensures Efficient System Functionality

A well-designed system ensures that resources (like hardware, software, and time) are used **efficiently**. It optimizes the processes involved in achieving the system's goals.

Example:

In an **e-commerce system**, the design ensures that when a customer clicks "Buy Now," the system processes the request efficiently, checks inventory, verifies payment, and updates the order database seamlessly.

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3. Identifies Potential Problems Early

Design helps **visualize and simulate the system** before implementation. This allows developers to identify **bottlenecks, redundancies, or other inefficiencies** early in the process and fix them before they become bigger problems.

Example:

When designing an **online banking system**, potential issues such as **user authentication delays** or **payment processing bottlenecks** can be detected in the design phase and addressed before development begins.

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4. Scalability and Flexibility

System design takes into account **future growth and adaptability**. It ensures that the system can handle **increased workloads or future feature additions** without major rework. This flexibility is vital in today’s rapidly changing technological landscape.

Example:

A **cloud-based file storage system** like Google Drive needs a design that can scale as more users upload data. A scalable design ensures the system can expand to accommodate billions of users while maintaining fast performance.

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5. Helps Meet User Requirements

A well-thought-out system design ensures that the system meets the **functional and non-functional requirements** outlined by users or stakeholders. This includes user-friendly interfaces, speed, security, and other criteria.

Example:

For a **mobile banking app**, the design will prioritize **ease of navigation, security features**, and **speed of transactions**, ensuring the app is both user-friendly and secure.

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6. Reduces Risks and Costs

By planning the system thoroughly in the design phase, the chances of encountering unforeseen **technical issues** or **costly revisions** during later stages of development are minimized.

Example:

A well-designed **inventory management system** helps avoid unnecessary overstocking or stockouts, reducing operational costs and improving supply chain efficiency.

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7. Better Communication Between Teams

System design provides a **common language** for stakeholders, including developers, project managers, business analysts, and clients. It ensures everyone is aligned and understands the overall vision and structure of the system.

Example:

In a **customer relationship management (CRM)** system, the design will show how the sales, marketing, and support teams interact with the system.

This common understanding allows all departments to align their efforts effectively.

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8. Improved Maintainability and Support

A well-designed system is easier to **maintain** and **upgrade** over time. The design can account for easy integration of future enhancements, updates, or bug fixes.

Example:

If a **website design** includes **modular components** for user authentication and product listings, it becomes easier to update or add new features without disrupting the entire system.

System design is a **critical phase in the development lifecycle**. It ensures that systems are built in a **structured, efficient, and scalable way**, meeting user needs while also accounting for potential growth, maintenance, and future enhancements. Proper system design reduces risks, enhances functionality, and streamlines communication across teams, ultimately leading to successful project delivery.

What is Information in SAD?

In System Analysis and Design (SAD), information is the processed, organized, and meaningful output derived from raw data. It plays a central role in designing and developing systems that help in decision-making, problem-solving, and management.

Data vs. Information (with Example)

Aspect	Data	Information
Meaning	Raw facts and figures	Processed and meaningful data
Example	80, 90, 85	Average score of 85 in three subjects
Use	Needs processing	Directly useful for decision-making

Example:

- Data: Name: Rahul, Age: 30, Salary: ₹60,000
- Information: Rahul is eligible for a housing loan based on his age and salary.

Purpose of Information in SAD

Information is used to:

- Help **design better systems** by understanding user needs.
- Support **business decisions** with reliable data.
- Ensure **proper communication** between system components.
- Improve **system efficiency** and **customer satisfaction**.

Characteristics of Good Information

1. **Accurate** – Free from errors.
    - *E.g., A salary report without miscalculations.*

2. **Timely** – Available when needed.
    - *E.g., Real-time traffic info for navigation.*

3. **Relevant** – Pertinent to the user's needs.
    - *E.g., Inventory info for a warehouse manager.*

4. **Complete** – Contains all required details.
    - *E.g., A student profile with full academic records.*

5. **Understandable** – Easy to comprehend.
    - *E.g., Charts and dashboards instead of raw tables.*

6. **Secure** – Protected from unauthorized access.
    - *E.g., Banking information with encryption.*

Information Flow in a System

A system processes information in the following stages:

1. Input Stage:

- Raw data is collected.
- **Example:** Employee ID, working hours, sales amount.

2. Processing Stage:

- Data is analyzed and organized.
- **Example:** Calculating total sales or monthly salary.

3. Output Stage:

- Final, meaningful information is produced.
- **Example:** Payslip, Sales Report, Performance Graph.

4. Feedback Stage:

- Used to make improvements or changes in the system.
- **Example:** System alerting if stock goes below threshold.

Real-Life Example: Banking System

🔹 **Data Collected:**

- Name, account number, transaction details, amount.

🔹 **Information Generated:**

- Balance status, mini statements, loan eligibility, fraud alerts.

🔹 **Use of Information:**

- Helps bank managers decide on loan approval.
- Allows customers to track transactions via mobile apps.
- Triggers alerts if unusual activities are detected.

Role of Information in SAD Phases

SAD Phase	Role of Information
1. Planning	Helps identify what system is needed and how it will support the business.
2. Requirement Analysis	Collects information on what users need from the system.

3. Design	Plans how information will be input, processed, stored, and output.
4. Implementation	Builds system to manage information effectively.
5. Testing & Maintenance	Ensures information is correct, secure, and performs as expected.

Why Information is Important in SAD

- Drives the **entire system design** process.
- Ensures **system objectives align** with business goals.
- Helps improve **user satisfaction** and **business performance**.
- Forms the **basis of reports, decisions, and automation**.

Systems Analyst – A Profession

A **Systems Analyst** is a professional who works to improve the efficiency of business systems by analyzing, designing, and implementing information systems that meet organizational needs. They act as a critical bridge between the business side and the IT department.

Why Do Businesses Need Systems Analysts?

In today's digital and data-driven world, businesses need technology to manage operations, customer relationships, decision-making, and more. But technology on its own isn't enough — it has to fit the **specific needs** of a business. That's where **Systems Analysts** come in.

Here's **why** businesses need them:

1. Align Business and Technology

- Businesses often have goals, but not the technical expertise to build the tools to reach them.
- Systems analysts understand both business goals and technical capabilities, translating needs into solutions.

2. Improve Efficiency

- They analyze current systems to find flaws or inefficiencies.
- Propose better workflows, automation, or integration of systems to save time and cost.

3. Support Decision-Making

- They gather data and provide insights that help management make informed choices about software investments, upgrades, or process changes.

4. Reduce Risk

- By conducting **feasibility studies** and thorough system testing, analysts reduce the risk of failed projects or costly mistakes.

5. Adapt to Technological Change

- As new technologies emerge, analysts help businesses upgrade or transition smoothly, minimizing disruption.

Users and Analysts in Various Functional Areas

Every business department uses technology differently. Systems Analysts must understand the unique needs of **users** in different **functional areas**:

1. Finance

- Users need systems for accounting, budgeting, payroll, and financial forecasting.
- Analysts work to integrate financial software, ensure compliance, and improve reporting accuracy.

2. Marketing

- Analysts support tools like CRMs, email marketing platforms, and web analytics.
- Help with campaign tracking, customer segmentation, and automation.

3. Human Resources (HR)

- HR uses systems for recruitment, onboarding, training, and performance evaluation.
- Analysts help implement HRIS (Human Resource Information Systems) and ensure they are user-friendly and secure.

4. Operations

- Systems manage supply chains, inventory, production schedules.
- Analysts optimize workflows, integrate logistics software, and track performance.

5. Sales

- Sales departments rely on tools like CRM, order management, and lead tracking.
- Analysts ensure these tools are properly configured to help sales teams succeed.

Role of a Systems Analyst

The role is **multifaceted**, combining elements of **technology, communication, business analysis, and project management**.

Key Responsibilities:

1. **Gather and Analyze Requirements**
    - Interview stakeholders to learn what the system must do.
    - Understand user needs, business goals, and pain points.
2. **Conduct Feasibility Studies**
    - Evaluate whether the proposed solution is practical, affordable, and beneficial.
    - Consider technical, economic, operational, and legal factors.
3. **Design Systems**
    - Create models like data flow diagrams, entity-relationship diagrams, and system architecture.
    - Decide how data moves, where it's stored, and how users interact with the system.
4. **Write Detailed Specifications**
    - Document how the system should work so developers can build it correctly.
5. **Communicate with Developers**
    - Translate business language into technical requirements.
    - Ensure developers understand the purpose and functionality of the system.
6. **Test Systems**
    - Plan and run tests to find bugs or issues before launch.

- Validate the system against business needs.

7. **Support Implementation**
    - Oversee system rollout, train users, and help transition from old to new systems.
8. **Maintain and Improve Systems**
    - Continuously monitor system performance.
    - Recommend updates, patches, or replacements as needed.

Duties of a Systems Analyst

To summarize, here's a list of typical duties:

Duty	Description
Requirement Analysis	Meet with users to identify system requirements.
Documentation	Create flowcharts, data models, and system design documents.
System Design	Outline how the system will work, including databases, interfaces, and workflows.
Liaison Role	Communicate between business teams and technical teams.
Testing	Plan and carry out tests to ensure the system is reliable.
Training	Teach users how to use new systems; create manuals and guides.
Project Support	Assist in managing timelines, budgets, and deliverables.
Maintenance	Evaluate system performance over time and implement updates.

Qualifications of a Systems Analyst

Educational Background

Most Systems Analysts have at least a **Bachelor's degree** in one of the following fields:

- **Computer Science**
- **Information Technology (IT)**
- **Management Information Systems (MIS)**
- **Software Engineering**
- **Business Administration (with IT specialization)**

Some roles may require or prefer a **Master's degree** in IT, Business Analytics, or an MBA with a tech focus.

Certifications (Optional but Advantageous)

- **CBAP** – Certified Business Analysis Professional
- **CompTIA Project+** – for project management skills
- **PMI-PBA** – Professional in Business Analysis
- **ITIL Certification** – for IT service management
- **Certified Systems Analyst** – offered by various tech institutions

Experience

- Entry-level analysts may start in support or junior analyst roles.
- Advanced roles may require **3–5 years** of experience with system design, development, or project management.

Analytical Skills

Analytical thinking is at the **core of what a Systems Analyst does**. These skills help them understand problems, break down complex systems, and propose effective solutions.

Key Analytical Abilities:

- **Problem-Solving**: Identify root causes and explore alternatives.
- **Critical Thinking**: Evaluate multiple options and anticipate impacts.
- **Data Analysis**: Interpret data to understand system performance or business trends.
- **Detail Orientation**: Spot inconsistencies, errors, or areas for improvement.

  Example: When a system crashes frequently, an analyst traces logs, tests inputs, and identifies whether it's due to software bugs, overloaded servers, or user error.

Technical Skills

Though not programmers, Systems Analysts need **strong technical foundations** to understand how systems work and to communicate effectively with IT teams.

Essential Technical Skills:

- **Database Knowledge**: SQL, data modeling, ER diagrams.
- **Programming Basics**: Understanding of languages like Java, Python, or C# (for communicating with developers).
- **System Design Tools**: Use of CASE tools, flowchart software, UML diagrams.
- **Operating Systems & Networks**: Knowledge of Windows, Linux, cloud platforms, and basic networking.
- **Software Development Life Cycle (SDLC)**: Understanding methodologies like Agile, Waterfall, or DevOps.
- **Business Intelligence Tools**: Familiarity with tools like Power BI or Tableau is a plus.

  Example: When designing a new inventory system, the analyst may create mockups, define database tables, and outline how data will flow from input to reporting.

Management Skills

Systems Analysts often lead or coordinate projects, so **basic project management** and organizational skills are a must.

Key Management Skills:

- **Time Management**: Prioritize tasks and meet deadlines.
- **Project Coordination**: Manage small teams or project components.
- **Risk Assessment**: Anticipate obstacles and plan backups.
- **Budget Awareness**: Estimate costs and work within project budgets.
- **Documentation & Reporting**: Maintain clear records of processes and outcomes.

  Example: During a system upgrade, the analyst might create a timeline, assign tasks, track progress, and report to upper management.

Interpersonal Skills

One of the most **underrated but crucial skill areas** for a Systems Analyst is interpersonal communication. They work with many people across departments.

Important Interpersonal Skills:

- **Communication**: Explain complex ideas in simple terms to non-technical users.
- **Listening Skills**: Accurately understand user requirements and feedback.
- **Teamwork**: Collaborate with developers, users, testers, and stakeholders.
- **Negotiation & Persuasion**: Balance the needs of users with system limitations.
- **Empathy**: Understand the end-user's experience and challenges.

Example: If users find a system difficult to use, the analyst must listen, understand the pain points, and work with the team to improve usability.

Summary Table: Key Qualifications & Skills

Category	Key Elements
Qualifications	Bachelor’s in CS, IT, or related field, certifications (CBAP, PMI-PBA, etc.)
Analytical Skills	Problem-solving, critical thinking, data analysis
Technical Skills	SQL, databases, system modeling, basic programming
Management Skills	Project coordination, planning, risk assessment
Interpersonal Skills	Communication, teamwork, listening, empathy