

## # 2 Systems Approach & Engineering

### Definition of a System

- System is a whole, consisting of interdependent or interacting parts with a purpose
- System is taken apart it loses its essential property
- System is NOT the sum of its parts

A system  $> \sum$  of its parts

**Definition:** A system is an organised / complex whole, a group of parts interacting in a coordinated way

1. Parts of the system affect the system and are affected by it.
2. The group of parts does something (dynamic).
3. The assemblage is of interest

### System Concepts and Principles

#### Natural vs Human-made System

- Natural Systems: came into being by natural processes (planetary system)
- Human-made: designed and operated by people (human organizations)
- Projects exists for the purpose of creating new systems or changing human-made system

#### 1. Goals and Objectives

- Human-made systems are designed to do something - goals/objectives conceived by people
- Place to start is defining a goal of systems and a hierarchy of objectives
- Goals are broad & strategic, and can be broken down into objectives broken down into requirements

## 2. Elements and Subsystem

- Systems can be broken down into smaller parts
- These parts in combination form "assemblage" that constitutes a system
- Smallest part — element
- Parts of a system might be themselves a system — subsystem
  - Subsystem is a system that function as a component of a larger system

System → Subsystem → Subsubsystem → .... → element

## 3. Attributes

- Systems, subsystems, elements have distinguishing characteristics — attributes
- Describe the condition of system — qualitative/quantitative.
- Human-made systems — attributes are designed into the system for performance

## 4. Environment and Boundary

- Environment refers to anything that influences the behavior/outcome of the system yet lies beyond the control of system maker.
- System is separated from its environment by boundary.  
Might be difficult to identify boundary.

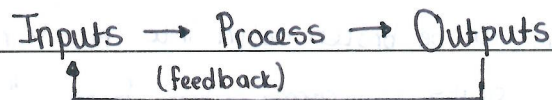
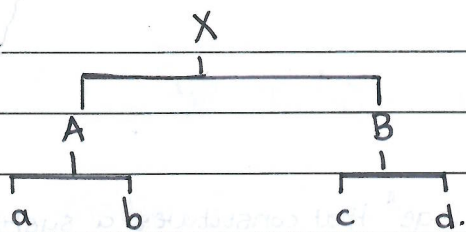
Two questions:

		is it relevant to the system.	
		Yes	No
Can decision maker control it	Yes	System	Irrelevant
	No	Environment	Environment

## 5. System Structure

- Elements & subsystems are linked together by relationships — structure of system
- Most systems, incl projects, can be conceptualized as hierarchical and network systems





hierarchical Structure

input process

## 6. Inputs, Process, Outputs

- Human-made systems achieve objects by converting inputs → outputs
- **Outputs:** end result of a system and the purpose
- **Inputs:** raw materials, resources, prior steps for the system to operate
- **Process:** means by which the system transforms inputs to outputs

## 7. Constraints and Conflicts

- Limitations that inhibit the ability of the system to reach goals  
     ↳ time and money
- Human-made systems the objectives sometime conflict, reduces the ability of them or the overall system
- Removing conflicts enables the overall system to meet objectives  
     — integration

## 8. Integration

- System to perform effectively and achieve goals, all elements must work in unison
- **Integration:** designing, implementing, operating a system to achieve pre-specified objectives through coordinated functioning.

## 9. Open & Closed Systems

- Closed system is self contained — no regard for the environment
- Open system adapts to its environment
- Any system must be adaptable to its environment to be open
- Social system = open

# System Approach

Methodology for solving problems and managing systems that accounts for:

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1. Objectives and performance criteria of a system
2. Environment and constraints of a system
3. Resources of the system
4. Elements of the system, functions/attributes and performance measures
5. Interaction among elements
6. Management of the system
7. Methodology employs the models

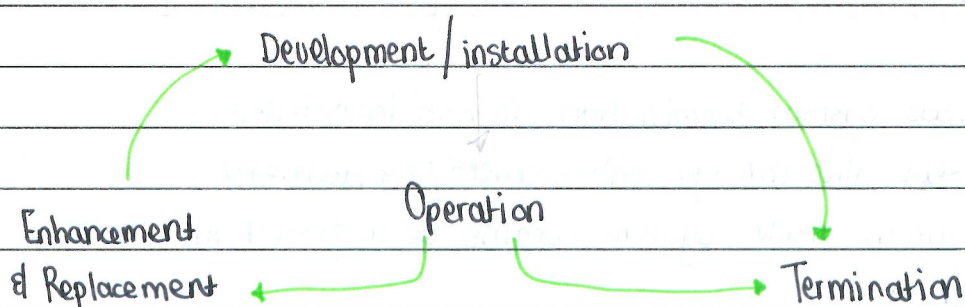
## System model

- Model is a simplified representation of the world, abstracts the essential features of the system
- Physical Model is a scaled down abstraction of the real system.
- Conceptual Model depicts the elements, structure and flow in terms of a schematic diagram / mathematical model.

## \* System Life Cycle

- Life cycle of a human-made systems is a series of logical, structured steps called the systems development cycle
  - conception — definition — design — development — fabrication — testing — launch — production — operation — maintenance.
- System Engineering prescribed stages for a large scale development project

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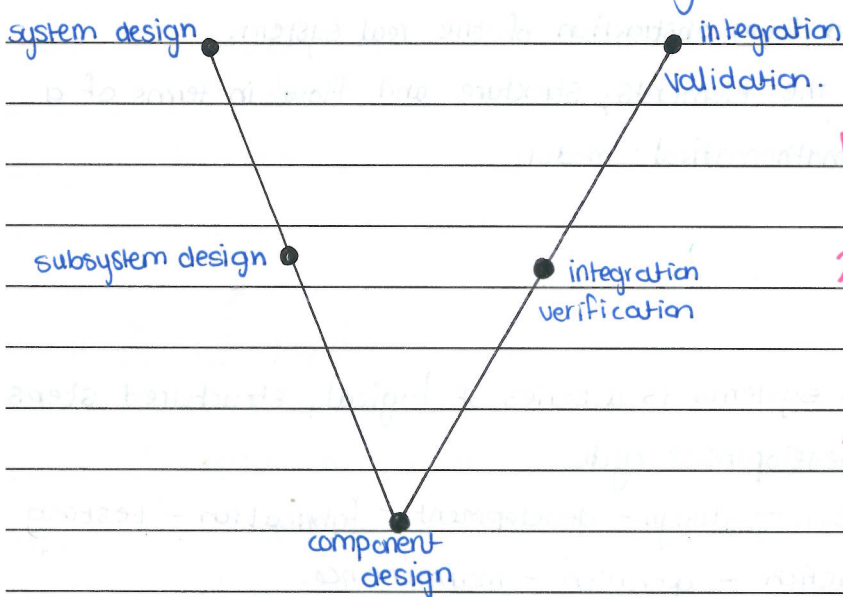
# \* System Engineering

Science of **designing complex systems** in their totality to **insure** that the components and subsystems **making up** the system are **designed, fitted together, checked, operated** in the most **efficient** way.

→ Way to bring the whole system **into being** and to **account** for its whole **life cycle** — incl operation and decommissioning.

## \* Dimensions of System engineering:

1. SE is a **multifunctional**, interdisciplinary concurrent effort  
→ needs become the basis for **defining system requirements**
2. Addresses the systems **structure and elements**, its functional and physical design
3. Takes into account the way system will be produced, operated maintained and finally disposed of — **entire life cycle**.



1. top-down analysis of details (decomposing system into parts)
2. bottom-up synthesis (building up and integrating parts into successively larger parts)
3. evaluation (results = requirements)

## # 3 System development Cycle and Project Conception

- Human made system **termination** is not inevitable.
- System kept alive through **enhancement/replacement**
- Every human made system begins as a project and ends as another project