SISTEM MODELING

Materi 2

System Thinking

System Thinking

- Increased Complexity of Today's Decision Making
  - The 20th century has been marked by unprecedented technological progress
  - Information Technology has revolutionized commercial activities
  - The creation of huge multi-national corporations
  - The problems of overpopulation and others
- Today's world has increased in complexity
- The traditional methods of problem solving based on the cause-and effect model cannot cope any longer.

Construction of the Aswan Dam

- Intended to increased agriculture production
- It also caused an unprecedented increased in schistosomiasis (affected 60% fellahin)
- It trap fertile silt, increase use of fertilizers
- Together with poor drainage causes salinization ⇒ land unsuitable for agriculture
- Destroyed the sardine fisheries
- Uncontrollable growth of water hyacinthin Lake Naser ⇒ lost of water

Deterioration of Urban Transport

- Increased car owner after WW II
  - ⇒ Improve the road network & parking facilities ⇒ Reduce patronage of public transport facilities ⇒ resulted fare hikes & curtailment of service frequency & coverage.
  - ⇒accelerated the shift from public to private transport.
  - What would have happened if the city father had chosen to upgrade public transport rather that upgrading the road network?

Assessment of Unit Production Costs

- Unit production cost is all material, energy, & labor costs then dividing the total by number of parts produce.
- The efficiency assessed on level of unit production cost.
- That rule works fine for simple one stage production process, when no difficulties in selling all its output
- How if we faced with complex multi-product – multi-stage process? The machine center's looks good, but ends up with excessive intermediate parts stocks that are costly to finance & maintain & run the risk of obsolete

Efficiency versus Effectiveness

- The firm may be very efficient in the use of its resources, but this efficiency is not put to effective use in term of the firm's overall objectives of goals.
- Technical efficiency, using a given set input to produce the maximum level of output, or producing a given level of output with the minimum amount of input.
- Economic efficiency, in term of maximizing the difference between revenues & total cost.

- Effectiveness, looks at how well the goals of activity are achieved.
- Trade-off between variables will affect overall effectiveness of the system.
- Efficiency is minimizing waste and maximizing utilization of resource.
- Efficiency is not the enemy of effectiveness.
- Efficiency takes overall goals of organization into account.
- Effectiveness deals with 'doing the right thing'.
- Efficiency deals with 'doing thing right'.

Unplanned & Counterintuitive Outcomes

- Action A will cause the desired outcome B to be realized.
- But in addition to B, A also causes C, D, and E to happen
- Some of these outcomes are unintended, unpredicted, and may negate the outcome B.
- Some of the outcomes may be counterintuitive (contradictive with the common sense and intuition)

Reductionist and Cause-And-Effect Thinking

- The traditional scientific model of thought are based on two major ideas: Reductionist and Cause-and-Effect Thinking
- **Reductionism:** Everything can be reduced, decomposed, or disassembled to ultimately simple parts.
  - Breaking a problem into a set of simpler subproblems, solving each of these individually and then assembling their solutions into overall solution for the whole problem.
  - But sum of individual solutions does not necessary produce a best solution for the whole system

- **Cause-and-Effect Thinking**
  - All phenomena are explainable by using cause-and-effect relationship.
  - A is taken to be the cause of B
  - Viewing the world in this way, everything can be explained by decomposing it into parts and looking for cause-and-effect relationship between the parts.
  - But it may be inadequate to examine the causal relationship one by one.
  - New properties may emerge through the interaction between the parts (emergent properties).

Systems Thinking

- **With the systems thinking**, something to be explained is viewed as parts of a larger whole, **a system**, and is explained in term of its role in that system.

Systems Concept

- Defining Systems:
- Out-There View of Systems
  - e.g., our solar system (sun & its 9 planets).
  - Seen as absolute; Exists out-there; Viewed as independent of observer.
- Inside-us View of Systems
  - Depend on what the person viewing something as a system
  - Different people may define the same system in different way.
  - Not seen as existing independently of the observer;
  - Not out there;
  - Become a mental construct;
  - Personal to the observer.

Defining Systems

- Systems as a Human Conceptualization
  Only human observer that may view something as a system.
- For examples:
  - An estuary is viewed as a beautiful place (not a system)
  - A few feet away from the path (not a system)
  - As an ecological system
- The point that system are human conceptualization is clearly driven home by the fact that majority of system conceive are not our personal view of some real assembly of thing out there in the real world.

Subjectivity of Systems Description

- World view of observer/Weltanschauung (personal factors)
- Effect of Previous Knowledge
- System's definitions are subjective
  - Cannot be labeled "right" or "valid" & "wrong" or "invalid"
  - Valid for the person making it
  - Dependent on **the aim and purpose** for building it

Formal Definition of The concept System

1. A system is an organized assembly of components
2. The system does something.
3. Each component contributes towards the behavior of the system and is affected by being in the system.
4. Groups of components within the system may by themselves have properties (1)-(3) i.e., they may form subsystem.
5. The system has an outside- an environment.
6. The system has been identified by someone as of special interest.

The Crucial elements of a system

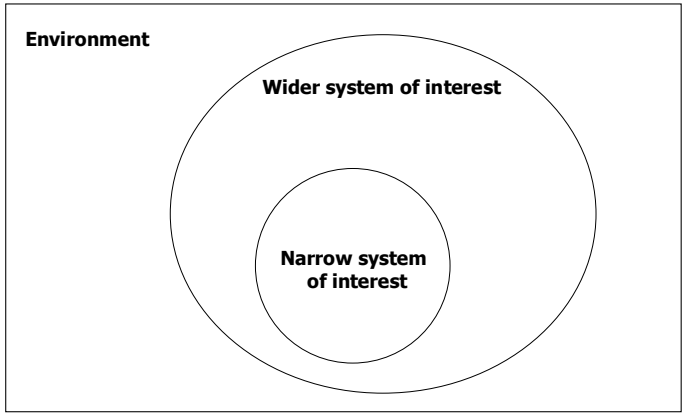
- Component
- Relationship
- Behavior (or the activities or the transformation process)
- Environment
- Input from environment; Output to environment
- Special interest of the observer

  (Some examples of systems description, see A traffic system; A motor vehicle; A sawmill)

System as Black Boxes

- The complexity of real live ⇒ have no or only incomplete knowledge of the inner workings of system, even where the physical components are able to identify.
- This lack of knowledge is affected by random aspects.
- In other situation the transformation process is known exactly. However, rather than represent it in full detail, it may be perfectly adequate to view as black box by single functional relationship.

Hierarchy of Systems



- Hierarchy system is the nesting systems within systems.
- The containing system becomes the environment of the contained system.
- Containing system exercise some control over the contained system.
- The controlling may set the objective of the contained system, monitoring it achieve the objectives, & have control over some crucial resources needed.
- The controlling system referred to as the **wider system of interest**, while the contained system becomes the **narrow of interest**.

System Behavior

- **System state**, the set of value assumed by all state variables as of given point in time.
  - State variables are attributes of system component, at any point in time each state variables has a given numerical or categorical value.
- **Variety of system behavior**, system behavior can be almost infinitely varied, even for very simple system. (e.g. newscaster light bulb)
- **Emergent properties**, the system exhibits behaviors that none if its component individually may exhibits. "The whole is greater than the sum of its part".

Types of Systems

- Discrete system, the states of system jumps through a sequence of discrete states.
- Continuous system, the state of the system change continuously, because there are continuous variables.
- Deterministic system, the behavior is predictable in every detail.
- Stochastic system, the behavior is not completely predictable, affected by random or stochastic inputs.
- Closed system, is one that not receive anything from its environment.
- Open system, interact with the environment, by receiving inputs from it & providing output to it.

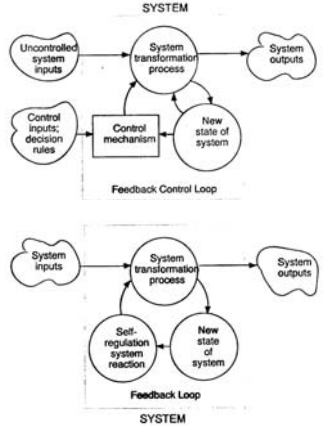
Control System

- Control is exercised by imposing something on the system in form of inputs
  - A set of decisions or decision rules, or simply an initial state for the system.
- Three conditions are needed for exercising control over system behavior
  - A target, objective, or goal for the system
  - A system capable of reaching the target or goal
  - Some means for influencing the system behavior - the control inputs

Types of controls

- Open loop controls
  - Often in the form of a recipe or a set of rules to follow (e.g. starting the engine)
- Closed loop controls (Feedback controls)
  - Information about the system behaviour is fed back to the controller for evaluation.
  - This may lead the controller to adjust the control signals (e.g. Control the temperature of the shower water)
- Feedback controls and Self Regulation
  - Feedback controls: The rules supplied from external systems
  - Self Regulation: The rules are internal (See Fig. 3-4)

Figure 3-4: Feedback control and self-regulation



System in a decision making context

- **A system** is an organized set of components and relationships that do something that none of the components can do alone.
- We use **system models** as a convenient way to view something in order to aid decision making (to solve a problem).

Alan Sexton

- **A System is described by:**
- **Observer**: Who is interested in the system? *Decision maker*
- **Purpose**: Why define the system? *Improve, output of interest*
- **Environment**: outside the system. Define the system boundary
- **Inputs**: Affect the system but are not affected by it. Can be controllable or uncontrollable. *Decision variables/parameters*
- **Outputs:** Are affected by the system. These are of interest to the observer. *Include measure of success*
- **Components**: Both affect and are affected by the system.
- **Relationship/transformation process**: Between system inputs, outputs and components.

Alan Sexton