CENG 6103 System Analysis and Management Techniques I

Chapter 1
Introduction

Introduction

Alternative Names:

- operational research
- operations analysis
- systems analysis
- decision analysis
- etc.

Systems Analysis - Introduction

Definition

1. SA/OR is the application of scientific methods, techniques and tools to problems involving the operations of systems so as to provide optimum solutions to the problems.

2. SA/OR is the application of the scientific method to the study of the operations of large, complex organizations or activities and to the analysis and solution of managerial decision problems.

3. SA/OR frequently attempts to find a best solution – called the optimum solution - for a given problem.

Systems Analysis - Introduction

Definition - summary

- Application of SCIENTIFIC METHOD
- Study of LARGE & COMPLEX SYSTEMS
- Analysis of MANAGERIAL PROBLEMS
- Finding OPTIMAL SOLUTION

Origin of the Operations Research Science

- Industrial revolution
  - change in organization size and complexity, it becomes more and more difficult to allocate and utilize resources efficiently.
- Second World War
  - More advanced as there was an urgent need to allocate the scarce resources to the various military operations.
- Computer revolution

Systems Analysis - Introduction

Systems Analysis - Characteristics

- managerial decision making
- scientific approach
- system approach
- mathematical models (computers) modelling approach

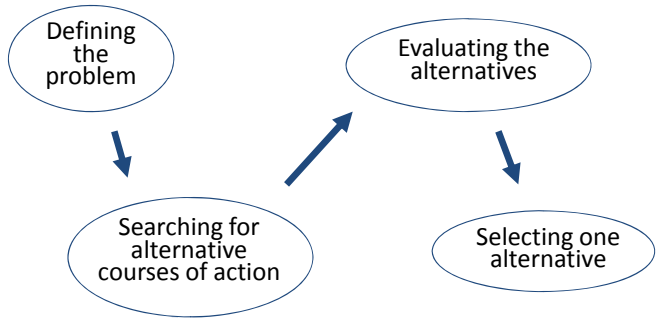
Systems Analysis - Introduction

Decision Making

- 2 or more alternatives
- Conclusion = Decision
- Systematic process

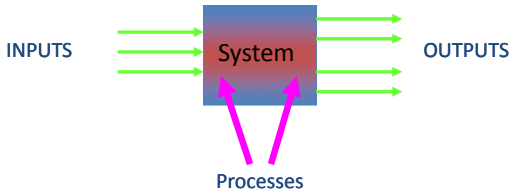
Systems Analysis - Introduction

Systematic Process



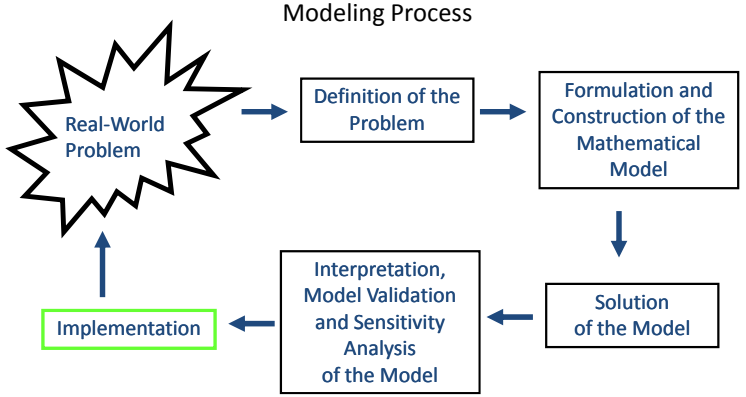
Systems Analysis - Introduction

System Approach



Systems Analysis - Introduction

Modeling Process



Systems Analysis - Introduction

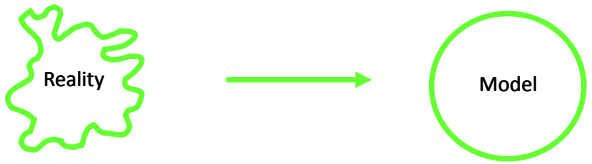
Mathematical Model : is the system of equations that describe the problem. It includes

- Decision Variables
- Objective function
- Constraints (represented in terms of inequalities or equations)

For example : profitability of an organization
factors that affect the profitability (such as number of products, price, production time, etc.)

Systems Analysis - Introduction

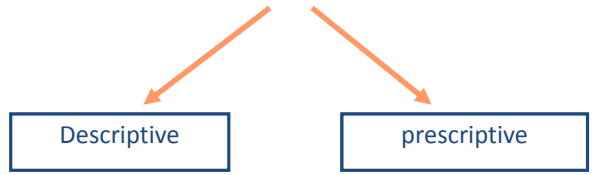
Mathematical Model



Finding a proper balance between the level of simplification of the model and the good representation of reality.

Systems Analysis - Introduction

Types of models



for a given set of inputs and initial conditions, a description of the outputs through time

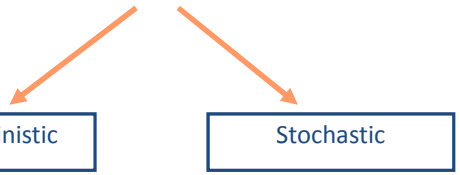
"If I follow this course of action, what will happen?"

suggests the best strategy to choose from all possible strategies.

"What is the best course of action that I might follow?"

Systems Analysis - Introduction

Types of models



parameter values are determined and known at the outset.

(end-of-period material production)

models might utilize data elements that are not precisely known but can be characterized by a mean and some random variation about the mean.
(end-of-month content of a reservoir)

Systems Analysis - Introduction

Model Solution

- Infeasible
- Feasible
- Optimal
- Sub optimal

Systems Analysis - Introduction

System analysis/Management Techniques

- Linear Programming
  - *linear objective function – min/max*
  - *linear constraints*
- Integer LP, Binary LP, Mixed Integer LP
- Nonlinear Programming
  - *nonlinear objective function and/or*
  - *nonlinear constraints*

Systems Analysis - Introduction

System analysis/Management Techniques

- Distribution Models
  - *special type of LP problems (special structure of model)*
  - *transportation problem*
  - *assignment problem*

Systems Analysis - Introduction

System analysis/Management Techniques

- Multicriteria Decision Making
  - *multiple criteria*
  - *compromise*
  - *limited/unlimited number of alternatives*
  - *goal programming*

Systems Analysis - Introduction

System analysis/Management Techniques

- Network Models
  - *network – nodes, arcs*
  - *evaluated network*
  - *minimal distance, maximal flow etc.*
- Project Management
  - *planning, scheduling & controlling projects*
  - *CPM, PERT*

Systems Analysis - Introduction

System analysis/Management Techniques

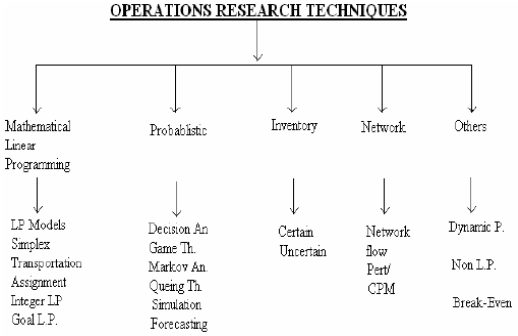
- Inventory Models
  - *when to order?*
  - *how much to order?*
  - *deterministic/probabilistic models*
- Waiting Line Models (Queuing Models)
  - *servers, customers*
  - *goal – optimal number of servers*
  - *analytical approach, computer simulation*

Systems Analysis - Introduction

System analysis/Management Techniques

- Simulation models
  - *computer experiments with models*
  - *complex systems*
- Theory of Games
  - *2 or more decision makers*
  - *possible strategies*

Operation Research techniques



Example

- This model deals with the development and expansion of an electric power system for a specific region.
- Let us assume that the new power station will be sited not far from the grid network of existing power lines.
- Demand is expected to grow over the next twenty years, so new power station is needed to supply that demand.
- In addition to demand, other needed data include the cost to build and operate various sizes of hydroelectric plants, wind power plants, Thermal power plants, and nuclear power plants.
- Proportional power losses along the segments of the network would likely be important information to have as well.

Example

- The objective is to meet demands for power at the least total cost where cost is the cost of building and operating the expanded system of power plants.
- The constraints are that each city must be assigned sufficient power resources from among all the plants, previously established or newly built.
- Decision variables may be considered building a plant of specific type or not.
- For example, decision variables may be 1 or 0. A variable for a plant of type *k at site i built to size j would be 1 if such plant were established and 0 other wise.*

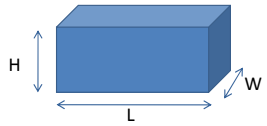
Example

Example: Designing a Tank

- Consider the problem of designing a tank to hold a specific amount of Volume *V,*
- Criterion : cost
- Objective: find the least-cost shape and dimensions of a tank of volume, v.

Example: Tank Design

- Assume a rectangular tank shape



- Design variable are L, W, H of the tank
- V, model parameter
- Objective: *L, W, and H* that minimizes the total cost

Example: Model & solution

- OF
  - Minimize *Cost* $= (C_{base} + C_{top})(LW) + 2(C_{side})\,(LH + WH)$
- *Constraint*
  - $LWH \geq V$
  - *Positive L,W,H*

- The least-cost solution show that *LWH will* equal *V*
- The least-cost solution is given:
  - $W = L = [2*C_{side} * V/(C_{base} + C_{top})]**1/3$
  - $H = V/[2*C_{side} *V/(C_{base} + C_{top})]**2/3$
  - or $H = V**1/3\ [(C_{base} + C_{top})/2*C_{side}]**2/3$

Example: Sensitivity analysis

- Sensitivity analyses performed on uncertain parameters or assumptions:
  - Cost parameters or the model itself
  - *How does the total cost change with respect to a change in any of the cost parameters or with the required volume V?*
  - *How much does any decision variable change with respect to changes in these parameters?*
  - Guide monitoring and data collection effort

Example

- The rectangular tank one of the designs!!
- Many other shapes , e.g.