System Modeling and Simulation

Introduction to Systems and Simulation

LECTURE (1.2)

System

Outline

- System and system environment
- Components of a system
- Discrete and continuous systems
- Model of a system
- Types of models

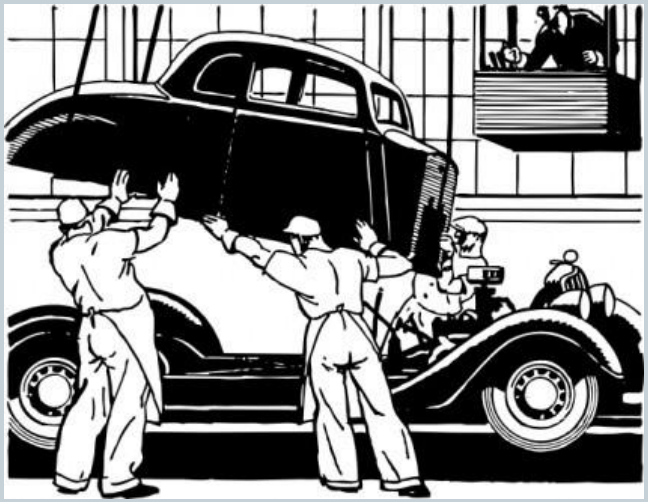
Systems

- Systems: is defined as a group of objects that are joined together in some regular interaction or interdependence towards the accomplishment of some purpose.

- System is a collection of entities (people, parts, messages, machines, servers, …) that act and interact together toward some end (to satisfy purpose if the system) (Schmidt and Taylor, 1970)
- Ex: system of bank, hospital, university,------etc

Systems

- Example:
- A production system manufacturing automobiles. Machines, components parts and workers operate jointly along assembly lines to produce vehicles

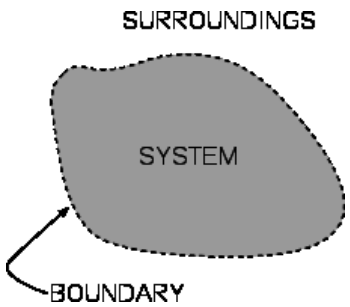


- A computer system : CPU , memory, disk, bus, NIC

System Environment

- A system is affected by changes that occur outside system boundaries. Such changes are said to occur in the *system environment*

Input and output (i/o) variable affected the system



Ex: Hair salon (arrival customers)

- Example: *Bank System (arrival customers)*
- Arrival customers are even affected the system of bank
- There is a limit on the maximum interest ratethat can be paid affected on bank system
- study of the effect of monetary laws on the banking industry and the setting of the limit rate would be an activity of the bank system

State of a system

- State of a system:

  Collection of variables and their values necessary to describe the system at that time

  - Might depend on desired objectives, output performance measures
  - Bank model: Could include number of busy tellers, time of arrival of each customer, etc.

System Components

- Entity
  - -An object of interest in the system. Such that CPU in computer system , Machines in factory,.....
- Attribute
  - The property of an entity. Such that speed, capacity, failure rate,.....
- Activity
  - A time period of specified length, even which entity can do
- State
  - A collection of variables that describe the system in any time : status of machine (busy, idle, down,...)

System Components

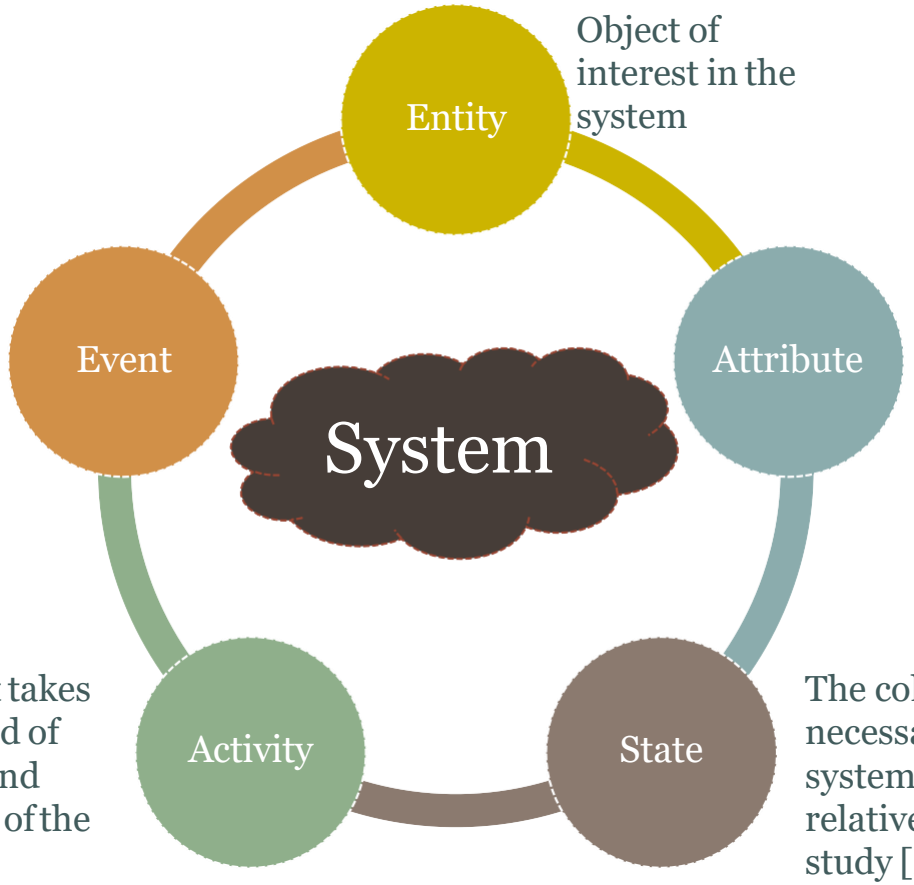
- Event
  - A instantaneous (represent) occurrence that might change the state of the system:

  Ex: customer come, customer go, packets come to server to handle, machine idle…….
- Endogenous
  - Activities and events occurring with the system
  - Ex: The customer deposited and spent money in the bank
- Exogenous
  - Activities and events occurring with the environment
  - Ex: customer in bank waited and go

System Components

Exogenous:
Activities and events occurring outside the system

System Components



Object of interest in the system

Property of an entity

The collection of variables necessary to describe the system at a particular time, relative to the objectives of the study [Law]

An action that takes place over a period of specified length and changes the state of the system

An instantaneous occurrence that may change the state of the system

Example

State Variables:
busy tellers, # customers waiting in line or being served, arrival time of next customer

Attribute:
Balance in the customers' accounts

Entity:
Customers

Activity:
Making deposits

Events:
Arrival, departure

Examples

System	Entities	Attributes	Activities	Events	State Variables
Railway	Passengers	Origin, destination	Traveling	Arrival at station, arrival at destination	Number of passengers waiting at each station
Production	Machines	Speed, capacity, breakdown rate	Welding, stamping	Breakdown	Status of machines (busy, idle, shutdown)
Communications	Messages	Length, destination	Transmitting	Arrival at destination	Number of packets waiting to be transmitted
Inventory	Warehouse	Capacity	Withdrawal	Demand	Level of inventory

Examples

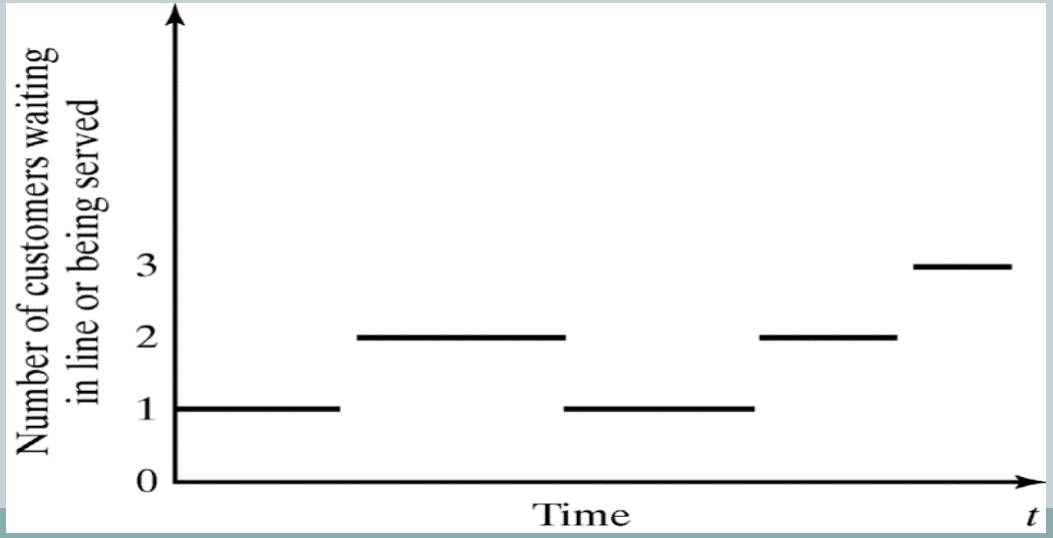
System	Entities	Attributes	Activities	Events	State Variables
Banking	Customers	Checking account balance	Making deposits	Arrival; Departure	number of busy tellers; number of customers waiting
university					
Hospital					

Types of Systems

A discrete system State variables of the system change only at discrete/separated set of points in time

Example: Bank Number of customers changes only when customer arrives or departs

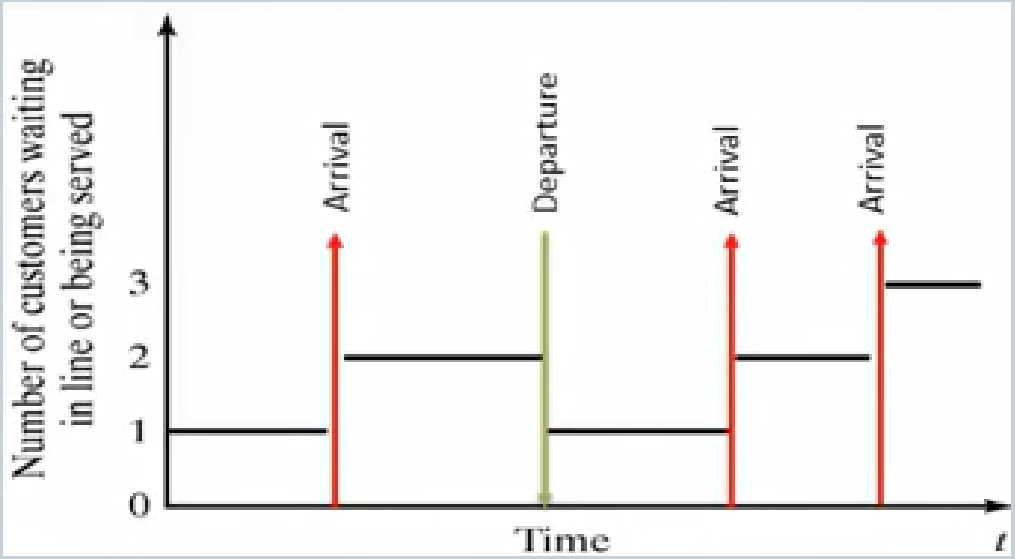
Example: Restaurant



Types of Systems

A simulation model in which system state evolves a discrete sequence of events in time

- System state changes only when an event occurs
- System state does not change between the events



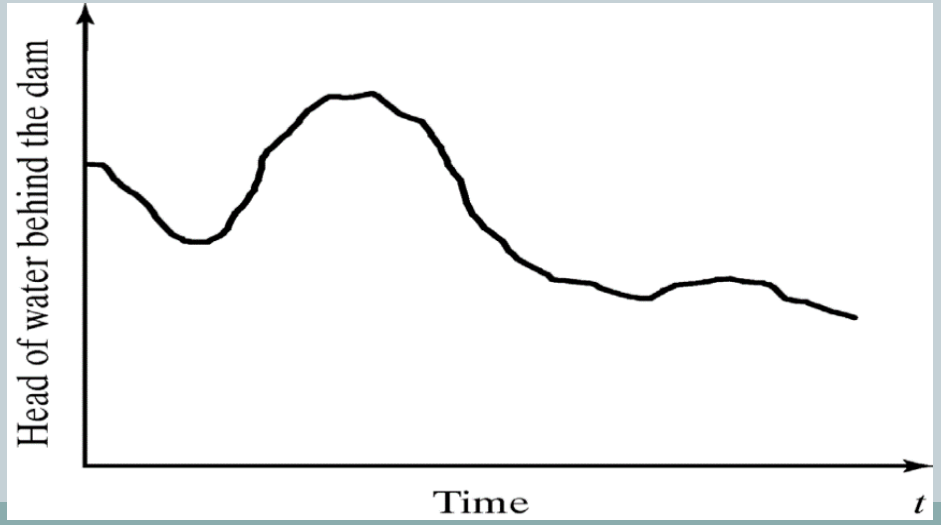
Types of Systems

Continuous system State variables of the change continuously over the time

Example: head of water behind the dam.

Example: Airplane flight

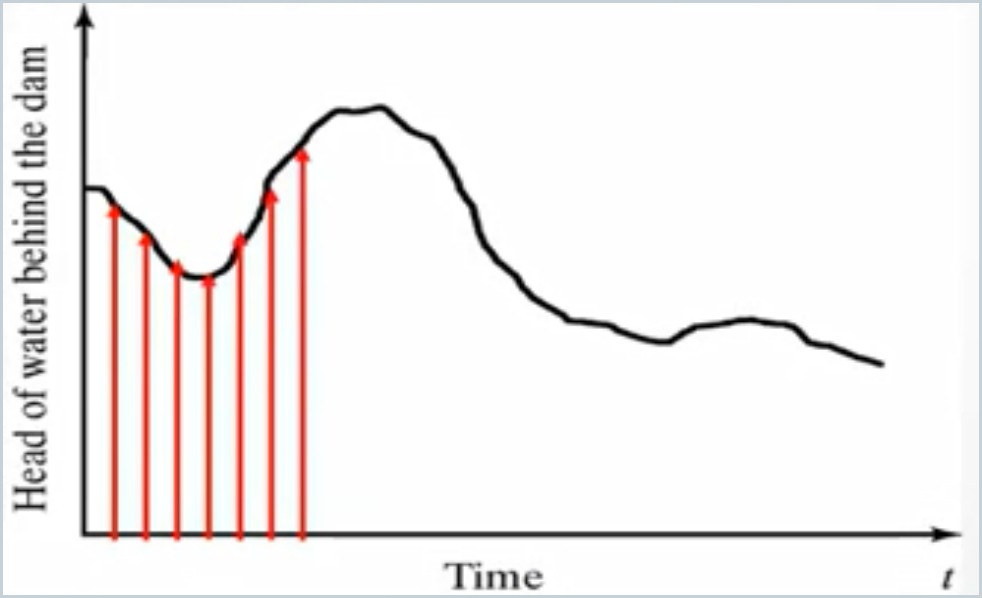
Position and velocity are continuously changing with respect to time



Types of Systems

A system model in which system state evolves continuously over time

- Time is divided to small time slices
- System state changes in every time slice



Why are Models Used?

- It is not possible to experiment with the actual system without design Models, e.g.: the experiment is destructive without model
- The system might not exist, i.e. the system is in the design stage

Example: system of Bank without design model

- Studying of reducing the number of tellers that effect on the length of waiting lines customers may caused annoy the customers such that they will be move their accounts to a competitor (anther bank)

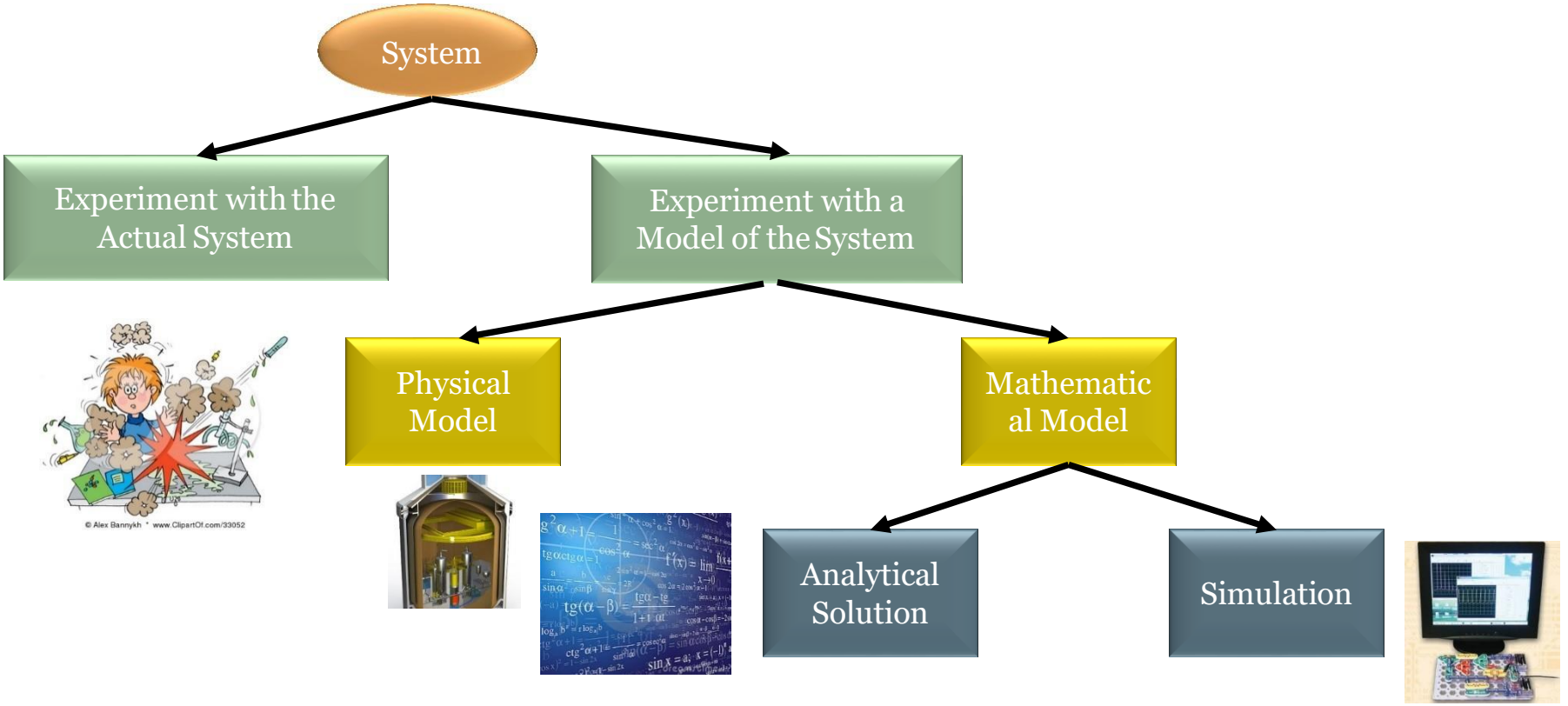
Models are important

- Because A model is a representation of a system for the purpose of studying that system
- It is only necessary to consider those aspects of the system that affect the problem under investigation (models determine the problem in the system witch can be investigate the solution)
- The model is a simplified representation of the system

Models are important

- The model should be sufficiently detailed to permit or provide me valid conclusions about the actual system
- Different models of the same system may be required as the purpose of the investigation changes
- By using model can remove Unnecessary details data

System with model type



Types of Models