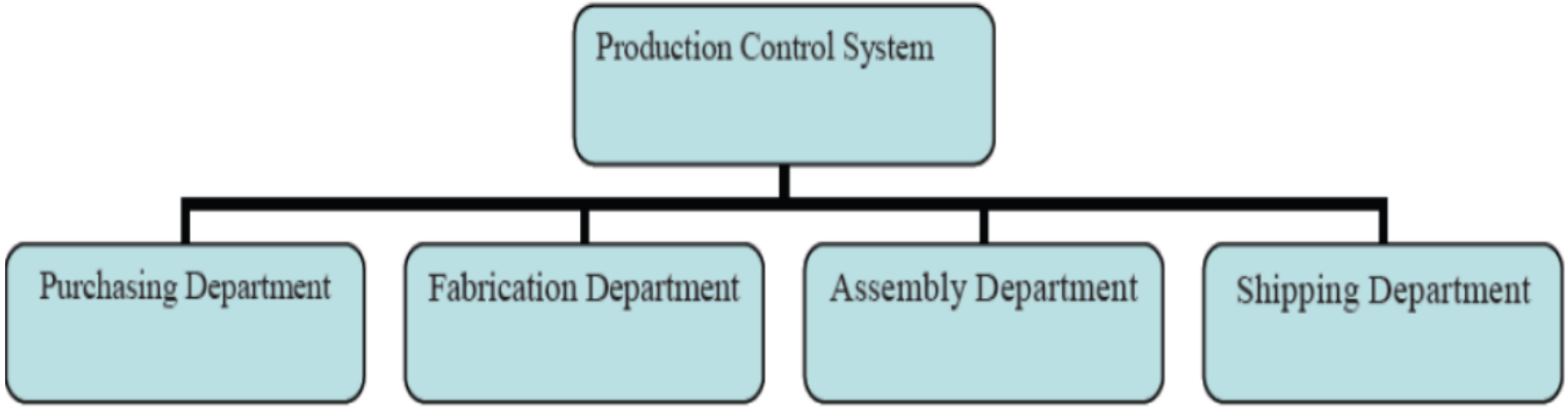
Simulation

- Simulation is the imitation of the operation of a real-world process or system over time.
- Simulation involves the generation of an artificial history of the system, and the observation of that artificial history to draw inferences concerning the operating characteristics of the real system that is represented.
- Simulation is the numerical technique for conducting experiments on digital computer, which involves logical and mathematical relationships that interact to describe the behavior and the structure of a complex real world system over extended period of time.
- The process of designing a model of a real system, implementing the model as a computer program, and conducting experiments with the model for the purpose of understanding the behavior of the system, or evaluating strategies for the operation of the system.

Simulation

System Concepts

- A system is defined as a group of objects that are joined together in some regular interaction or interdependence for the accomplishment of some task. For example: Production system for manufacturing automobiles.



Components of system

2.1 Entity, attribute and activities

An entity represents an object that requires explicit definition. An entity can be dynamic in that it moves through the system, or it can be static in that it serves other entities. In the example, the customer is a dynamic entity, whereas the bank teller is a static entity.

Example

System	Entities	Attributes	Activities
Traffic	Cars, bus, pedestrian	Speed, model	Driving, walking
Bank	Customer	Balance	Depositing, arrival of costomer, ….
Supermarket	Customers	Shopping list	Checking_out, …..

State variables

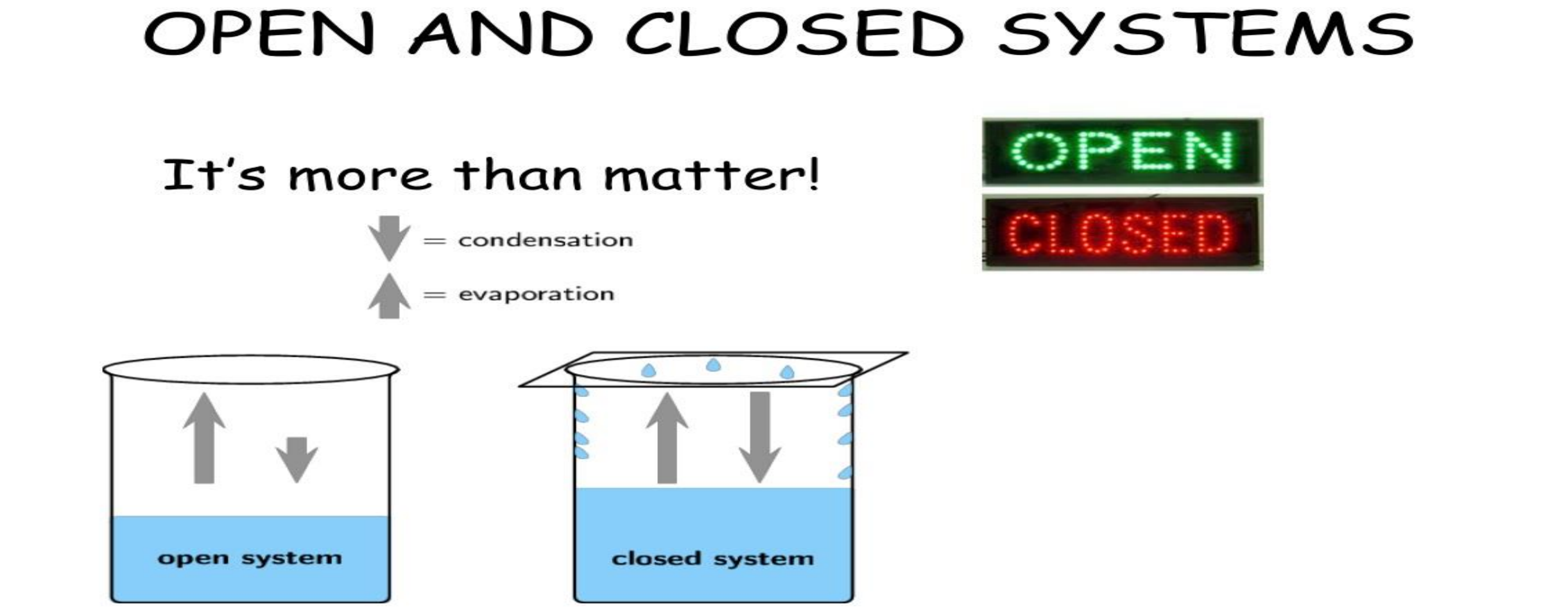
The state of a system is defined to be that collection of variables necessary to describe the system at any time, relative to the objectives of the study.

Example

System	*Entities*	*Attributes*	*Activities*	*Events*	*State Variables*
Banking	Customers	Checking account balance	Making deposits	Arrival; departure	Number of busy tellers; number of customers waiting
Rapid rail	Riders	Origination; destination	Traveling	Arrival at station; arrival at destination	Number of riders waiting at each station; number of riders in transit
Production	Machines	Speed; capacity; breakdown rate	Welding; stamping	Breakdown	Status of machines (busy, idle, or down)
Communications	Messages	Length; destination	Transmitting	Arrival at destination	Number waiting to be transmitted
Inventory	Warehouse	Capacity	Withdrawing	Demand	Levels of inventory; backlogged demands

Open System/Close System

A system with exogenous activities is considered as open system and a system with strict endogenous activities is called a closed system.



Systems

Systems Environment:

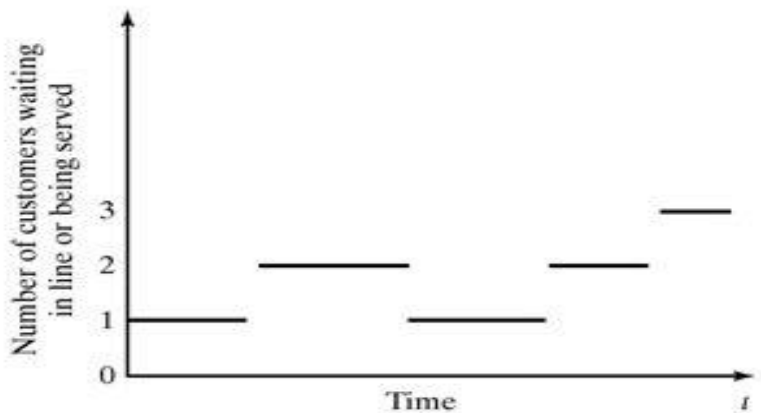
A system is affected by changes that occur outside its boundaries. Such changes are said to occur in the *system environment*

The *boundary* between the system and its environment depend on the purpose of the study

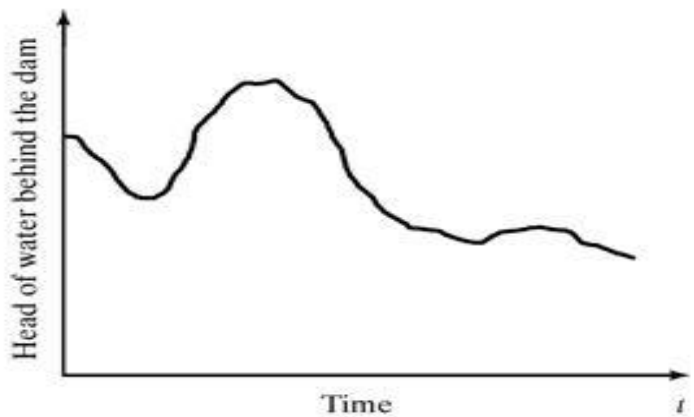
Endogenous	Exogenous
A variable in an economic model that exists within the model or system under analysis	A variable in an economic model that exists outside the model or system of analysis

Discrete and Continuous Systems

- Discrete system: in which state variable(s) change only at a discrete set of points in time.
  - e.g., the number of jobs in queue changes when a new job arrives or when service is completed for another
- Continuous system: in which state variable(s) change continuously over time.
  - e.g., the head of water behind a dam.



Discrete System



Continuous System

System Modeling

1.Model Definition and Purpose:

- A model represents a system for studying specific aspects of interest.
- It simplifies the real system, focusing only on components relevant to the problem under investigation.

2.Model Variation:

- Different system analysts may create varying models of the same system.
- Each model highlights different aspects depending on the analyst's focus and goals.

3.Model Development:

- **Establishing Model Structure**: Define system boundaries, entities, attributes, activities, and events.
- **Supplying Data**: Provide attribute values and define relationships involved in system activities

Types of Model

- Mathematical and Physical Model
- Static Model
- Dynamic Model
- Deterministic Model
- Stochastic Model
- Discrete Model
- Continuous Model