University of Msila

FACULTY OF MATHEMATICS AND INFORMATICS

DEPARTMENT OF COMPUTER SCIENCE

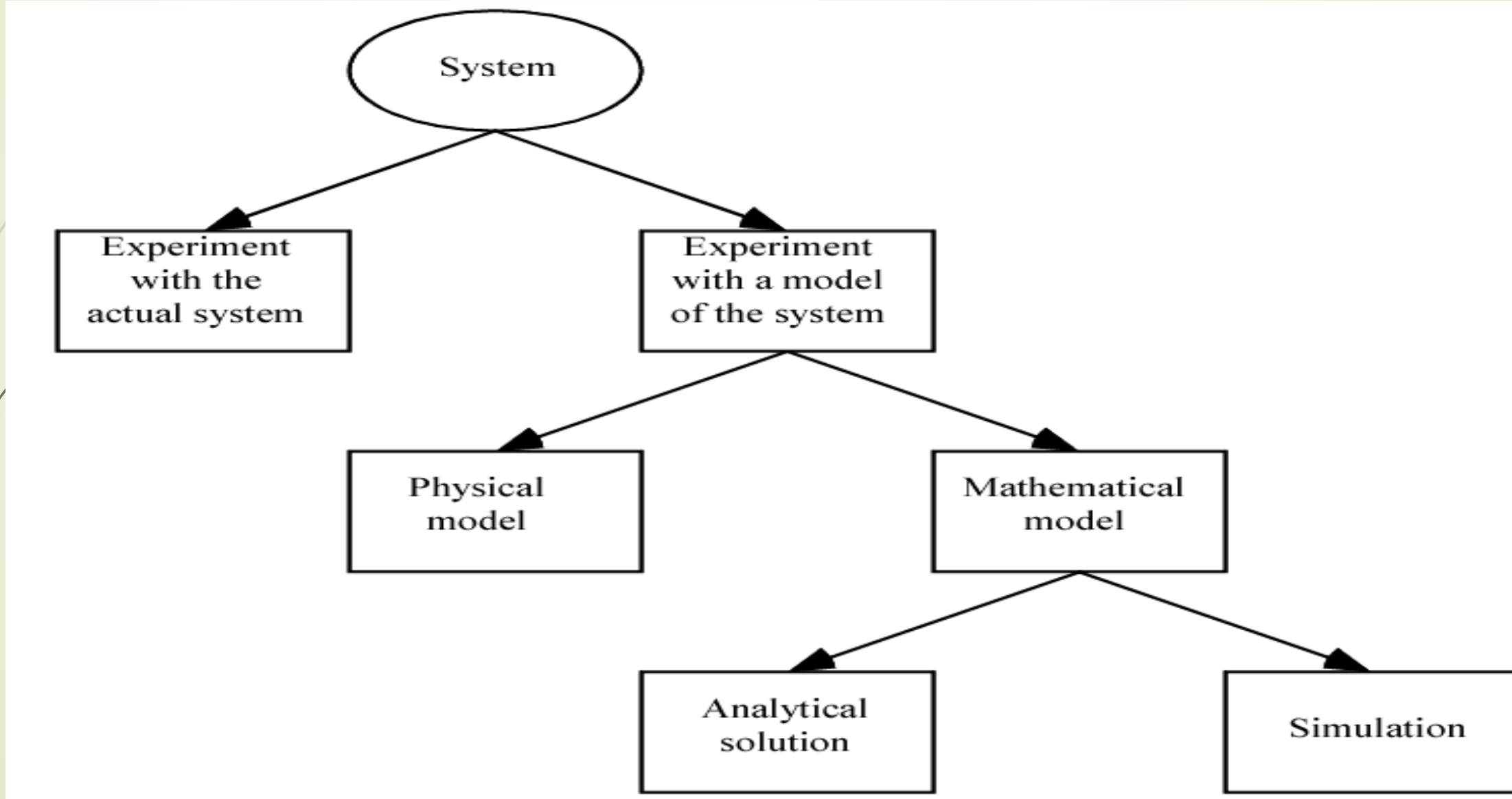
MODELING AND SIMULATION

Concepts and principles

Systems, Models & Simulation

- **System** is defined to be a collection of entities, e.g., people or machines, which act and interact together toward the accomplishment of some logical end.
- System depends on the objectives of a particular study.
- State of a system: collection of variables necessary to describe a system at a particular time, relative to the objectives of a study. *(the number of busy tellers, the number of customers in the bank, the time of arrival of each customer in the bank)*
- **Types of systems:**
  - **Discrete** : the state variables change instantaneously at separated points in time. (*a bank, e.g., the number of customers in the bank*)
  - **Continuous:** the state variables change continuously with respect to time. (*an airplane moving through the air, e.g., position and velocity*)
- **Study on a system**: try to gain some insight into the relationships among various components, or to predict performance under some new conditions being considered.
- **Ways to study a system:**

Systems, Models & Simulation



Systems, Models & Simulation

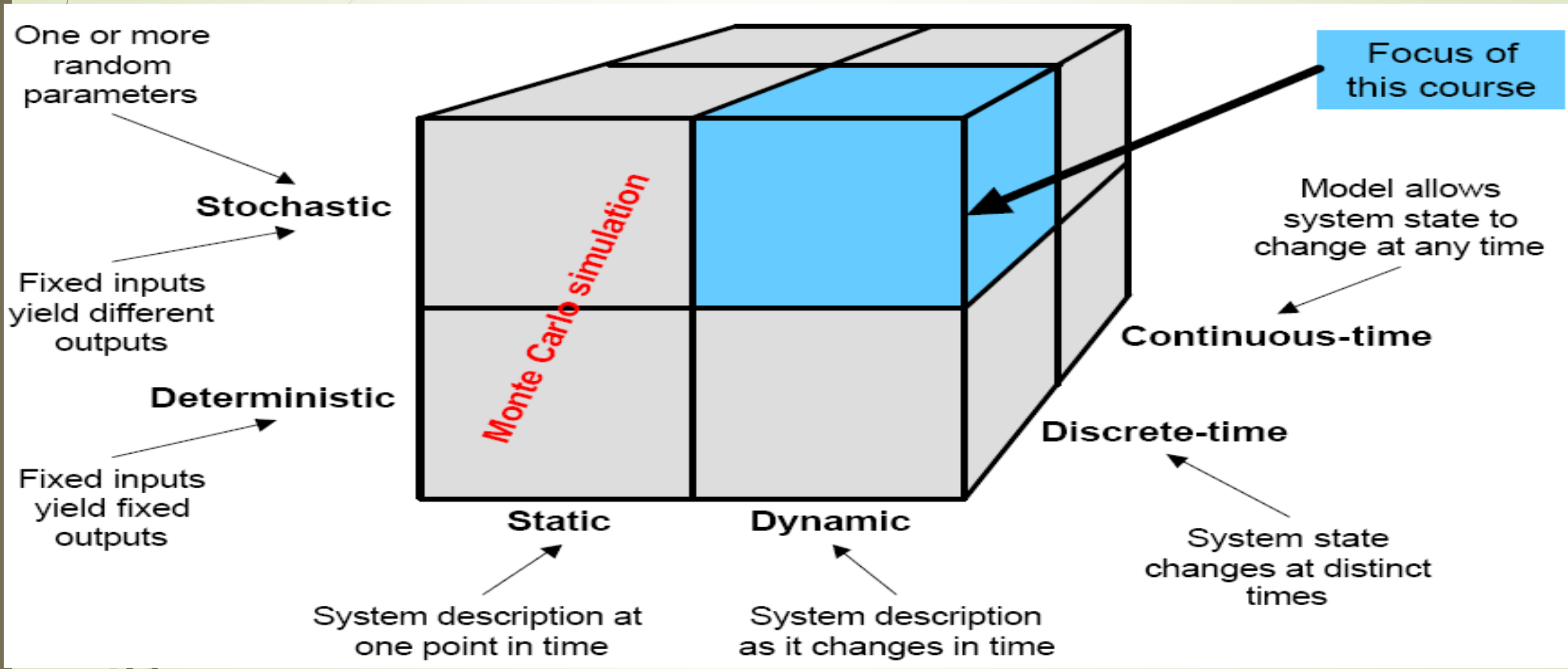
Example

- One study on a bank to determine the number of tellers needed to provide adequate service for customers who want just to cash a check or make a savings deposite, the system can be defined to be that portion of the bank consisting of the tellers and the customers waiting in line or being served.
- If the loan officer and the safety deposite boxes are to be included, the definition of the system must be expanded in an obvious way.

Systems, Models & Simulation

- Classification of simulation models
  - *Static* vs. *dynamic*
  - *Deterministic* vs. *stochastic*
  - *Continuous* vs. *discrete*
- Most operational models are dynamic, stochastic, and discrete – will be called *discrete-event simulation models*

Types of Simulation



Concept of model

- **Definition**

  - A **model** is a representation of a real system (physical, economic, human...etc.) created in order to better study this system and explain certain aspects of its behavior.

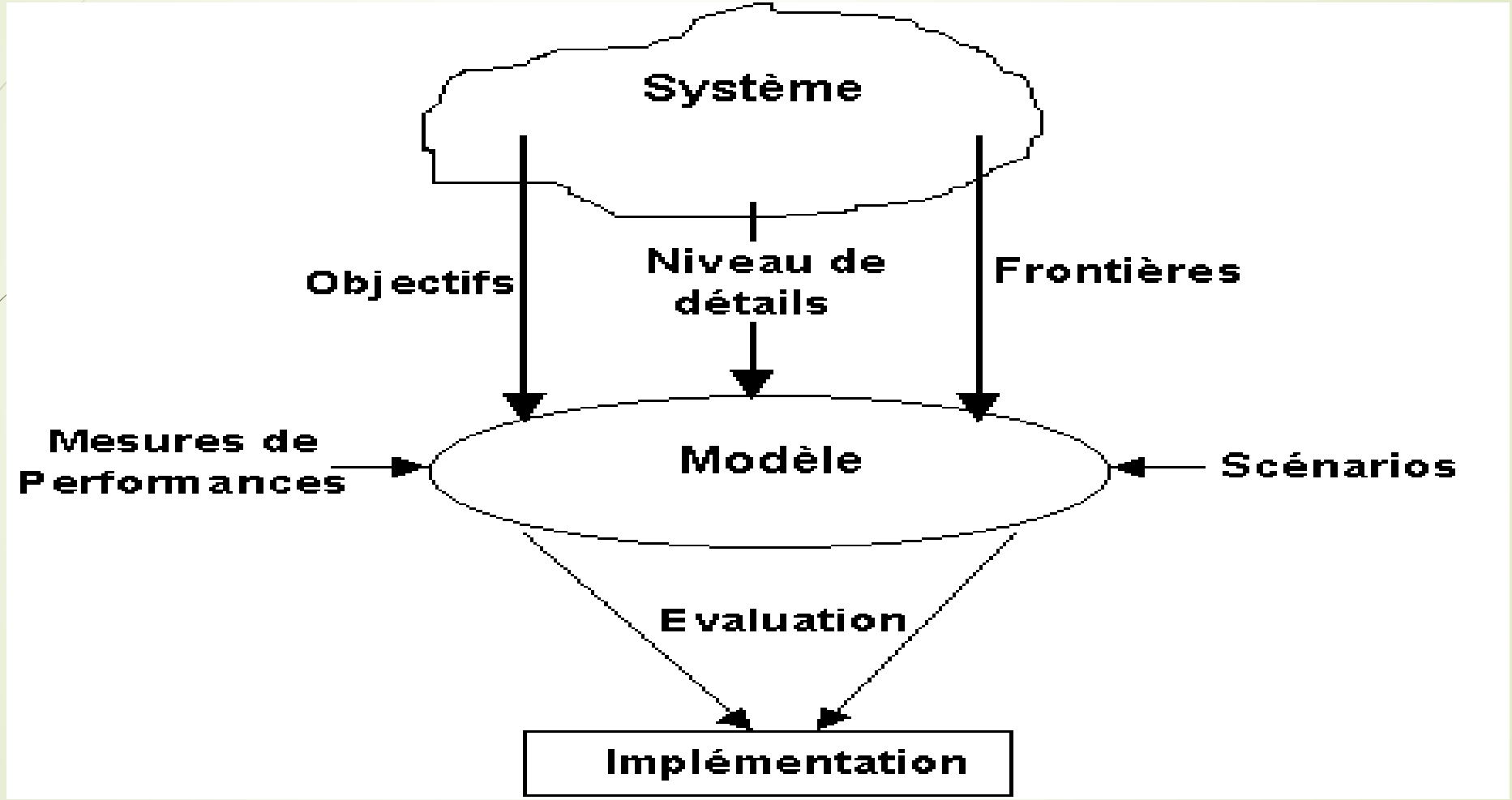
  - Sometimes, it is impossible to study the system directly, because it is inaccessible (solar system), too costly, changes too quickly (nuclear blast), or slowly (comet motion). In this case, the study is carried out on a model, i.e. a second system built for the occasion, and whose similarity to the original system is as perfect as the study requires.

  Example: A project to build an airplane involves the following steps
  1)Design a prototype airplane, then build a full-scale model using wood and plywood.
  2) Scale models of the aircraft are built using real materials. These models will be used to explain certain aspects (material resistance tests, flight and landing speeds, ...).
  3) The first "real" full-scale aircraft is built for testing. Results from the flight tests are collected, then compared with those obtained using the scale models. New parameters are updated, and model tests are repeated.

Model Classifications

- **deterministic** (input and output variables are fixed);
- **stochastic** (at least one of the input or output variables is probabilistic);
- **static** (time is not taken into account);
- **dynamic** (time-varying interactions among variables are taken into account).

Modeling process



Concept of simulation

- **Definition:**

Simulation is the study of the dynamic behavior of a system, using a model that evolves over time according to well-defined rules, for predictive purposes.

- The term simulation can be characterized by the following keywords:
  - A fundamental element is the **model**
  - The model is manipulated (on a computer), with the solutions found being those of the model and not of the system being modeled.
  - Its aim is to choose the solution that seems to be the best from among those available.

- Simulation can also be seen as indirect experimentation (on the model, not the system) to compare different ways of proceeding. It does not solve the problem by finding the right solution. It merely helps to select the best possible solution from among several.

Solving Problems Using Modeling and Simulation