Lecture (8): What is Model?

8.1 What is Model?

The model is an abstraction of the system obtained by making a set of assumptions about how the system works. It must capture the essential characteristics of the system. The term 'model' is used in many different situations and in many different ways: "anything can be a model of anything", "... every case of being taken as a model involves a restriction with respect to relevant properties". A model of a system is anything an "experiment" can be applied to in order to answer questions about that system.

The Model is similar to but simpler than the system it represents. One purpose of a model is to enable the analyst to predict the effect of changes to the system. A model should be a close approximation to the real system and incorporate most of its features. It should not be so complex that it is impossible to understand and experiment with it.

The most important aims of the model are:

- 1. Model helps us to visualize a system as it is or as we want it to be.
- 2. Model permits us to specify the structure or behavior of system.
- 3. Model document the decision we have made.

8.2 What is System?

A system might be an object or collection of objects whose properties we want to study. It may be thought as a collection of elements which are interdependent and interact. It can be thought of as a collection of entities which are logically related and which are of interest to a particular application. A system can be almost anything. It can contain subsystems which are themselves systems. The following features of the system are of interest:

- *Environment:* Each system can be seen as a subsystem of a broader system.
- *Interdependency:* No activity takes place in total isolation.
- *Sub-systems:* Each system can be broken down to sub-systems.

- *Organization:* Virtually all systems consist of highly organized elements or components, which interact in order to carry out the function of the system.
- *Change:* The present condition or state of the system usually varies over a long period of time.

8.3 What's being modeled?

Computer simulation deals with models of the system. A system is a facility or process, either actual or planned, such as:

- A manufacturing plant with machines, people, transport devices, conveyors belt and storage space.
- A bank with different kind of customers, servers, and facilities, like teller window, automated teller machine (ATM's), loan desks, and safety deposit boxes.
- An airport with departing passengers checking in, going through security, going to the departure gate, and boarding: departing flight; arriving passengers moving to baggage and waiting for their bags; and the baggage-handling system, and security issues.
- A distribution network of plants, warehouses, and transportation links.
- An emergency facility in a hospital, including personal, rooms, equipment, supplies, and patient transport.
- A computer network with service, clients, disk drives, tape drives printers, networking capabilities, and operators.
- A freeway system of road segments, interchanges, controls, and traffic.
- A fast-food restaurant with different types of stuff, customers, and equipment.
- A supermarket with inventory control, checkout, and customer's service.

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8.4 How about just playing with the system?

It might be possible to experiment with the actual physical system. For instance:

- Some cities have installed entrance-ramp traffic light on their freeway systems to experiment with different sequencing to find settings that make rush hour as smooth and safe as possible.
- Supermarket managers might try different policies for inventory control and checkout personal assignment to see what combinations seems to be most profitable and provide the best service.
- A computer facility can experiment with different network layouts and job priorities to see how they affect machine utilization and turnaround.

This approach certainly has its advantages. If you can experiment directly with the system and know that nothing else about it will change.

8.4.1 Sometimes you can't (or shouldn't) play with the system

In many cases, it's just too difficult, costly, or downright impossible to do physical studies on the system itself.

- Obviously, you can't experiment with alternative layouts of a factory if it's not yet built.
- Even in an existing factory, it might be very costly to change to an experimental layout that might not work out anyway.
- Trying a new check-in procedure at an airport might initially cause a lot of people to miss their flights.

In these situations, you might build a model for studying the system and ask questions about what would happen in the system if you did this or that, or if some situation beyond your control were to develop. Nobody gets hurt, and your freedom to try wide-ranging ideas with the model that you might not have been able to try with the real system.

8.5 Types of Models:



Models can be classified into two categories:

- Physical or
- Mathematical.

Physical model this is a physical object that mimics some properties of a real system, to help the designer answer questions about that system. For example, during design of artifacts such as buildings, airplanes, etc., it is common to construct small physical models with same shape and appearance as the real objects to be studied, e.g. with respect to their properties.

Mathematical models represent a system in terms of logical and quantitative relationships that are then manipulated and changed to see how the model reacts, and thus how the system would react provided the model is valid.

Mathematical modeling is the art of translating problems from an application area into mathematical formulations whose theoretical and numerical analysis provides insight, answers, and guidance useful for the originating application.