Modeling & Simulation

Lecture 2

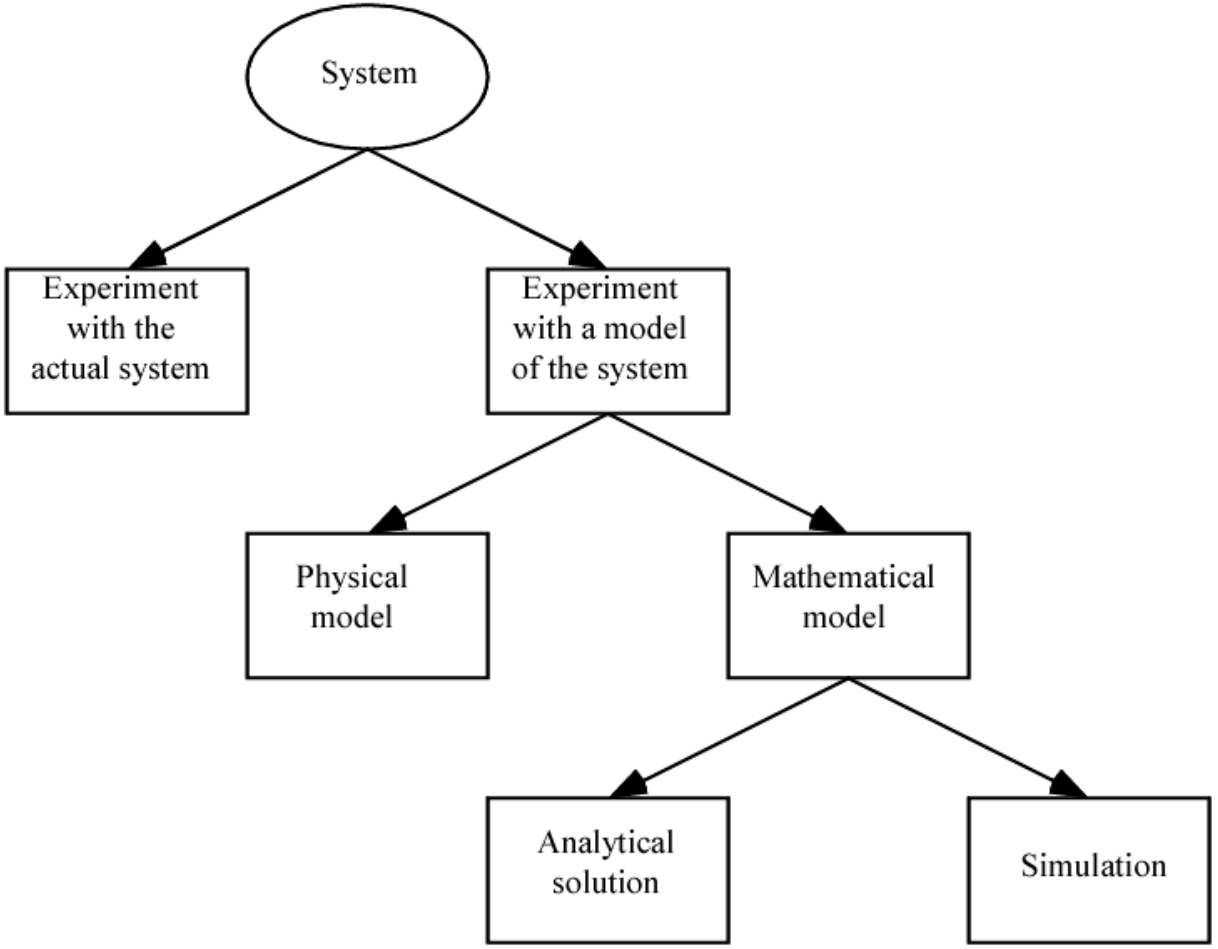
What is Simulation?

- Simulation is a concept that involves building a model, which mimics reality. The term simulation was derived from the Latin *simulare* , which means to pretend . Simulation can be defined as an experiment performed on a model .
- Shannon [1975] defines simulation as an "experimental and applied methodology which seeks to:
- describe the behavior of systems;
- construct theories or hypotheses that account for the observed behavior;
- Use these theories to predict future behavior, that is, the effects that will be produced by changes in the system or in its method of operation.

What is Simulation?

- Besides that, Simulation can be defined as a tool that evaluates the performance of a system, existing or proposed, under different configurations of interest and over long periods of real time.
- The term ' Computer Simulation ' means designs a model of an actual or theoretical physical system, execute the model on a digital computer, and analyze the execution output.

Systems, Models, and Simulation



Systems, Models, and Simulation

- Classification of simulation models
  - Static vs. dynamic
  - Deterministic vs. stochastic
  - Continuous vs. discrete
- *Deterministic* models are models which do not contain the element of probability. Examples are: linear programming, non-linear programming and dynamic programming.
- *Stochastic* models are models which contain the element of probability. Examples are: queuing theory, stochastic processes, and simulation techniques

Systems, Models, and Simulation

- *Continuous* simulation is a model in which systems change continuously over time, a continuous simulation model is characterized by its state variables, which typically can be described as functions of time
- *Discrete* simulation models are only concerned with what happens to the individual elements in the system and will jump to that next step.

The History of Simulation

- The early years:
- In the late 1950s and 1960s, simulation was a very expensive and specialized tool that was generally used only by large corporations. Typical simulation users were found in steel corporations. These organizations would form groups of people, mostly PH.D.s, who would develop large, complex simulation models using available languages, such as FORTRAN. These models would then be run on large mainframes.

The History of Simulation

- The formative years:
- The use of simulation as we know it today began during the 1970s and early 1980s. Computer were becoming faster and cheaper, and the value of simulation was begin discovered by other industries, it become the tool of choice for many companies, especially in automotive and heavy industries, and for determining why disaster occurred.

The History of Simulation

- The resent past:
- During the late of 1980s, simulation began to establish its real roots in business. A large part of this was due to the introduction of the personal computers and animation. Although simulation was still being used to analyze failed system, many people were requesting simulation before production was to begin. By the end of 1980s the value of simulation was being recognized by many large firms, several of which actually made simulation a requirement before approval of any major capital investment.

The History of Simulation

- The present:
- During 1990s, better animation, greater ease of use, faster computers, and easy integration with other packages has all helped simulation to become a standard tool in many companies.

Advantages of Simulation

- *Compressing Experiment Time*
- Because the model is simulated on a computer, experimental simulation runs may be made in compressed time. This is a major advantage because some processes may take months or even years to complete .Lengthy system processing times may make robust analysis difficult or even impossible to perform. With a computer model, the operation and interaction of lengthy processes can be simulated in seconds.

Advantages of Simulation

- *Reducing cost*

You can create experiments that in the real world would take many pieces of equipment or would imply in the utilization of expensive materials. The use of a simulation is particularly interesting, when the purpose is just to show a property or to skill a given ability.

- *Variables can be accessible*

In a simulation all variables can be studied and controlled, even those that are inaccessible in real system.

Advantages of Simulation

- *Easily Demonstrated Model*

Most simulation-specific software packages have the capability of dynamically animating the model operation. Animation is useful both for debugging the model and also for demonstrating how the model works. Animation-based debugging allows the expert to observe flaws in the model logic easily. This includes dynamically demonstrating how the system model handles different situations.

Advantages of Simulation

- *Evaluating the system performance*

Simulation can be used as a tool for evaluating a system's performance under different configuration, the system does not need to exist, and it can just as well be proposed system. Regardless of which, the result from simulation can be used to determine which configuration of a system that has the best performance and how the system should be constructed.

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- *Simulation is flexible*

Any situation, no matter how complex, can be investigated through simulation.

Advantages of Simulation

- *Simulation can be used to answer a variety of questions*

  It is possible to evaluate e.g. waiting times, job rates and fault percentages from one and the same model.

- *Simulation is easy to understand*

  In essence, it is nothing but replaying a modeled situation. In contrast to many analytical models, little specialist knowledge is necessary to understand the model.

Disadvantages of Simulation

- Although simulation has many advantages, there are also some disadvantages of which the simulation practitioner should be aware. These disadvantages are not really directly associated with the modeling and analysis of a system but rather with the expectations associated with simulation projects. These disadvantages include the following:

Disadvantages of Simulation

- *Simulation Cannot Give Accurate Results When the Input Data Are Inaccurate*
- No matter how good a model is developed, if the model does not have accurate input data, the expert cannot reasonably expect to obtain accurate output data. Unfortunately, data collection is considered the most difficult part of the simulation process.

Disadvantages of Simulation

- *Simulation Cannot Provide Easy Answers to Complex Problems*

Some analysts may believe that a simulation analysis will provide simple answers to complex problems. In fact, it is more likely that complex answers are required for complex problems. If the system analyzed has many components and interactions, the best alternative operating or resource policy is likely to consider each element of the system. It is possible to make simplifying assumptions for the purpose of developing a reasonable model in a reasonable amount of time. However, if critical elements of the system are ignored, then any operating or resource policy is likely to be less effective.

Disadvantages of Simulation

- *Simulation Alone Cannot Solve Problems*

Some managers may believe that conducting a simulation model and analysis project will solve the problem. Simulation by itself does not actually solve the problem. It provides the management with potential solutions to solve the problem. It is up to the responsible management individuals to actually implement the proposed changes

- *Simulation does not offer proofs.*

Whatever occurs in a correct simulation model may occur in reality, but the reverse does not hold. Things may happen in reality that has not been observed during simulation.

Simulation Programming Languages

- Simulation models can be developed by using two types of computer programming languages: general-purpose computer languages and special-purpose simulation languages. General - purpose computer languages, such as FORTRAN, C, BASIC, and PASCAL, Visual Basic, Visual C…, were designed to solve broad classes of problems and to develop simulation models,

Simulation Programming Languages

- while special-purpose simulation languages, such as SLAM, SIMAN, and GPSS, were designed to solve a particular class of problems. They have characteristic that make them more suitable to use for simulation systems and require a less programming effort.

Simulation Programming Languages

- Also, there were a *simulator*s, such as PROMODEL, ARENA, WITNESS … etc. They have the ability to simulate a system with little or no programming. The simulated system can be built by using a graphical interface with dropdown windows and icon.

Thank you...