INTRODUCTION TO MODELING & SIMULATION

Lecture One

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OBJECTIVES OF THE LECTURE

- The objectives of this lecture are to:
  - Define modeling and simulation, and discuss the fundamental concepts of modeling and simulation
  - Discuss the general characteristics of models
  - Discuss the general characteristics of simulations
  - Determine under which circumstances simulations are useful in engineering.

WHAT IS SIMULATION?

- A ***simulation*** is the imitation of the operation of a ***real-world process*** or system over time.
  - Simulation involves generating an ***artificial history*** of a system and drawing inferences.

- The behaviour of a system as it evolves is studied by developing a ***simulation model***.
  - ***Modeling refers to the process of generating a model as a conceptual representation of some phenomenon***
- This model takes the form of a ***set of assumptions*** concerning the operation of the system.
- The model takes a set of expressed assumptions:
  - *Mathematical, Logical*
  - *Symbolic relationship between the entities.*

DIFFERENCE BETWEEN SIMULATION AND MODELING

- **Modeling** is the act of building a **model**.
- A **simulation** is the process of using a **model** to study the behaviour and performance of an actual or theoretical system.
- **In a simulation**, **models** can be used to study existing or proposed characteristics of a system.

FORMS OF SCIENTIFIC MODELING

Business process modeling	Graphical modeling
Climate modeling	Hydrological modeling
Data modeling	Hydro-geological modeling
Ecological modeling	Mathematical modeling
Economical modeling	Medical modeling
Environmental modeling	Molecular modeling
Geologic modeling	Ocean modeling
Software modeling	Statistical modeling
Stochastic modelling	Thought experiment

WHEN SIMULATION IS THE APPROPRIATE TOOL

- Simulation enables the study of and experimentation with the internal interactions of a complex system, or of a subsystem within a complex system.

- Informational, organisational and environmental changes can be simulated and the effect of those alternations on the model's behaviour can be observed.

- The knowledge gained in designing a simulation model can be of great value in suggesting improvements in the system under investigation.

- By changing simulation inputs and observing the resulting outputs, valuable insight may be obtained into which variables are most important and how variables interact.

WHEN SIMULATION IS THE APPROPRIATE TOOL

- Simulation can be used as a device to reinforce analytic solution methodologies.
- Simulation can be used to experiment with new designs or policies before implementation so as to prepare for what may happen.
- Simulation can be used to verify analytic solutions.
- Simulation models designed for training allow learning without the cost and disruption of on-the-job learning.
- Animation shows a system in simulated operation so that the plan can be visualised.
- The modern systems are so complex that interactions can only be treated through simulation

WHEN SIMULATION IS NOT APPROPRIATE

- When the problem can be solved by common sense.
- When the problem can be solved analytically.
- If it is easier to perform direct experiments.
- If the cost exceeds the budget
- If resources or time are not available.
- If the system behaviour is too complex.
- If no data is available about that system, not even estimates.

ADVANTAGES OF SIMULATION

- Can be used to study existing systems without disrupting the ongoing operations.

- Proposed systems can be “tested” before committing resources.

- Allows us to control time.

- Allows us to identify bottlenecks.

- Allows us to gain insight into which variables are most important to system performance.

DISADVANTAGES OF SIMULATION

- Model building requires special training. It is an art that is learned over time and through experience.
- Results from a Simulation can be difficult to interpret because they are usually based on random inputs, which produce random outcomes.
- Simulation modeling and analysis can be time-consuming and

SIMULATION APPLICATIONS

- Examples are as follows:
- Estimating a set of productivity measures in production systems, inventory systems, manufacturing processes, materials handling, and logistics operations

- Designing and planning the capacity of computer systems and communication networks to minimise response times

- Conducting war games to train military personnel or to evaluate the efficacy of proposed military operations

- Evaluating and improving maritime port operations, such as container ports or bulk material marine terminals (coal, oil, or minerals), aimed at finding ways of reducing vessel port times

- Improving health care operations, financial and banking operations, and transportation systems and airports, among many others

THANK YOU