ELSEVIER

Information Sciences 124 (2000) 173–192

INFORMATION SCIENCES
AN INTERNATIONAL JOURNAL

www.elsevier.com/locate/ins

Applied system simulation: a review study

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Received 3 June 1998; accepted 15 March 1999

Communicated by Ahmed Elmagarmid

Abstract

This paper deals with a tutorial study of applied system simulation. We present the applications of system simulation, simulation types, and elaborate on discrete-event simulation, DES. Then we explain the level of details needed in a simulation model. We investigate the significance of simulation experiments and explain in detail the standard methodology used in the development of a simulation model. The steps include: problem formulation and planning, system abstraction, resource estimation, system analysis, verification and validation, and implementation. Finally, we present a detailed case study using SIMSCRIPT II.5 simulation language.

Keywords: System simulation; Discrete-event simulation; Trace-driven simulation; Applications of simulation

1. Introduction

The term simulate implies to imitate or mimic while the word modeling refers to a small object that represents some existing object. A simulation is the imitation of the operation of a system or process over time. The behavior of a system as it evolves over time can be studied by a simulation model. Since mimicking and modeling may be traced back to the beginning of civilization,

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the history of simulation and modeling is very old. With the advances in computer and telecommunication technology, the art and science of modeling and simulation have experienced a remarkable transformation [1–11].

The behavior of a system as it evolves with time can be studied using a simulation model. Such model takes the form of a set of assumptions regarding the system under study. The assumptions are represented by mathematical, logical and symbolic relationships. These relationships are between the entities (objects) of the system. After the model is developed, it is verified, and validated. Then, it can used to run simulation experiments in order to investigate a wide variety of questions and behaviors of the system.

Simulation of systems can be used for the following reasons:
1. It can be used to experiment with a new design or scheme before implementing it.
2. It can be used to enable the study of the internal interactions of a complex system or subsystem within a complex system.
3. It provides the analyst with a tool to conduct various experiments that can be done in real time or doing them could be catastrophic.
4. Organizational and environmental changes can be simulated and the effect of these changes on the model's behavior can be observed.
5. It can be a used as a tool to validate analytic results.
6. Simulation provides a flexible means to experiment with the system or its design. Such experiments can reveal and predict valuable information to the designer, user, manager and purchaser.
7. Simulation is a cost-effective tool for capacity planning and tuning of systems or subsystems.

Among the advantages of simulation are:
1. *Flexibility*: It permits controlled experiments.
2. *Speed*: It permits time compression operation of a system over extended period of time.
3. It permits sensitivity analysis.
4. No need to disturb the real system.
5. It is a good training tool.

However, simulation has some disadvantages. These are listed below:
1. It may become expensive in terms of computer time and manpower.
2. There are some hidden critical assumptions that may affect the credibility of the simulation outputs.
3. It may encounter extensive development time.
4. It may encounter difficulties in model's parameters initialization.

There are different types of simulation that can be categorized on the basis of the nature of the system under study, goals of simulation, and availability of facilities and tools. This section covers key ideas underlying any type of simulation. The components of a simulation model along with case studies are also presented.