INTRODUCTION TO SIMULATION MODELING

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INTRODUCTION

Since World War II system modeling has played an increasingly important role in the analysis of complex systems in both the private and public sectors. In the broadest sense, a model may be considered to be a representation of reality without the presence of reality itself. Hence, pictures, graphs, management games, computer programs, and mathematical equations may be considered models of those systems which they represent. For the purposes of this discussion we will restrict our attention to that class of models which attempts to capture the relationship between the behavior of a measure or measures of system effectiveness and the behavior of those variables and parameters which influence the measure(s) of effectiveness and includes analog, simulation and mathematical models. The specific focus of our attention will be on simulation models.

SYSTEMS ANALYSIS AND MODELING

To analyze the behavior of a system under a variety of operating conditions the analyst may choose to experiment with the physical system itself or carry out his experiments on a model of the system. As experimentation with the physical system is usually sufficiently disruptive to the functioning of the total organization or some part thereof, this alternative is usually infeasible or at least economically unattractive. At this point the analyst turns to analysis of the system through a model of the system.

The type of model chosen for the analysis is usually dependent upon the nature and complexity of the system and the capability of the analyst. In the analysis of organizational systems such as large corporations, governments, hospitals and the like, the system investigated is often represented through either a mathematical or a simulation model. The choice between a mathematical model and a simulation model depends upon the complexity of the system analyzed, the background and capability of the analyst and the history of success or failure of the two approaches to modeling within the organization.

The basic advantages of simulation modeling are versitility and simplicity. Many systems are sufficiently complex to defy a complete mathematical description while being amenable to representation through a simulation model. In other cases, the system studied may be amenable to mathematical analysis but the level of mathematical sophistication required is beyond the background or capability of the analyst while he may possess the capability to develop a valid simulation model. That is, for reasonably complex systems the level of mathematical sophistication required for development of a valid mathematical model is usually more extensive than that required for development of the corresponding simulation model.

In general the steps taken in the analysis of a system are the same whether the analyst chooses to use a simulation model or a mathematical model. These steps can be summarized as follows:

1. Problem identification
2. Specification of the objectives of the analysis
3. Identification of the operating characteristics of the system and the collection of data describing the behavior of the system
4. Formulation of the system model
5. Parameter estimation
6. Preliminary model validation
7. Development of computer programs if necessary
8. Final model validation
9. Experimentation with the model
10. Analysis of results.

The primary focus of attention of this tutorial will be on steps 4, 5, 6, and 8.

PURPOSE AND SCOPE OF THE TUTORIAL

The purpose of this tutorial is to present an introduction to the basic concepts of simulation model development. While full comprehension of the

material presented requires no previous exposure to simulation methodology, a fundamental understanding of probability, statistics and integral and differential calculus is desirable.

The specific topics to be discussed in the tutorial include

1. Generation of random numbers
2. Random variate generation
3. Static simulation models
4. Dynamic simulation models
5. Distribution identification
6. Validation.

Much of the material covered will be presented in the context of examples to illustrate the relationship among the topics presented.

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