SIMULATION

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Contents

INTRODUCTION

Simulation is a powerful and widely used management science technique for analysis and study of complex problems. It is one of the most widely used quantitative approaches to decision making.
Simulation analysis is a natural and logical extension of the analytical and mathematical techniques used for solving problems in Operations Research. Simulation, which can be called management laboratory, determines the effect of alternate policies without disturbing the real system.
The representation of reality is some physical form or in some form mathematical equations may be called Simulation that it is **Simulation is an imitation of reality**.
The basic idea of Simulation is to build an experiment device that will **act like** (simulate) the system of interest in certain important aspects.

INTRODUCTION

Simulation enables the successful use of organizational improvement programs such as Six Sigma. The activities of define, measure, analyze, improve and control depend on the earnest participation of everyone involved to manage quality. In particular, the last three (analyze, improve and control) revolve around identification of root causes, coming up with new policies and practices,and putting controls in place to keep quality high. Clearly, simulation can play the important role of reducing the risk of change and managing change.

NEED FOR SIMULATION

Using Simulation, an analyst can introduce the constants and variable related to the problem, set-up the possible courses of action and establish criteria which act as measures of effectiveness. The major reasons for applying simulation technique to O.R. problem may be listed as below:

- Simulation is an appropriate tool to use in solving a problem when experimenting on the real system (a) would be disruptive, (b) would be too expensive, (c) does not permit replication event (d) does not permit control over key variables.
- Simulation is a desirable tool to use in solving business problem when a mathematical model (a) is too complex to solve, (b) is beyond the capacity of available personnel, (c) is not detailed enough to provide information on all importance decision variable.
- Simulation provides a trial-and -error movement towards the optimal solution. The decision-maker selects an alternative, experience the effect of the selection, and then improves the selection. In this way, the selection is adjusted until it approximates the optimal solution.

SOME EXAMPLES OF SIMULATION MODELS

The Trading Gameis a group business simulation designed to get students thinking about and experiencing a wide range of entrepreneurial skills and activities.

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- **Planetarium** A model representing the planetary system projecting the images and motion of celestial object like stars, planets, and constellations.
- **Children cycling park** with various crossings and signals is a simulated model of the city traffic system.
- **Chess** It is a non-probabilistic simulation of a fight between black and white armies.
- **TV Games**: The combination of computing and simulation has resulted in the production of TV games.

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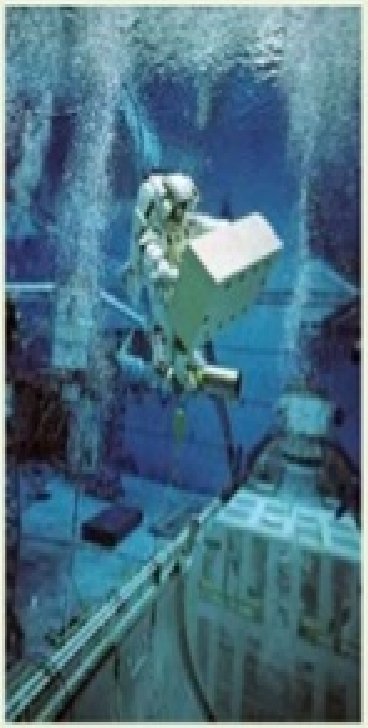
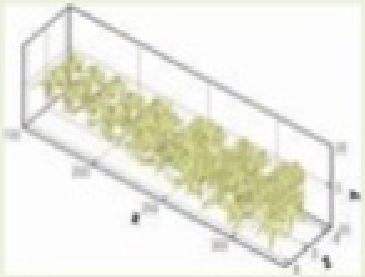


Human-in-the-loop simulation of outer space



Visualization of a direct numerical simulation model.

Life simulation games

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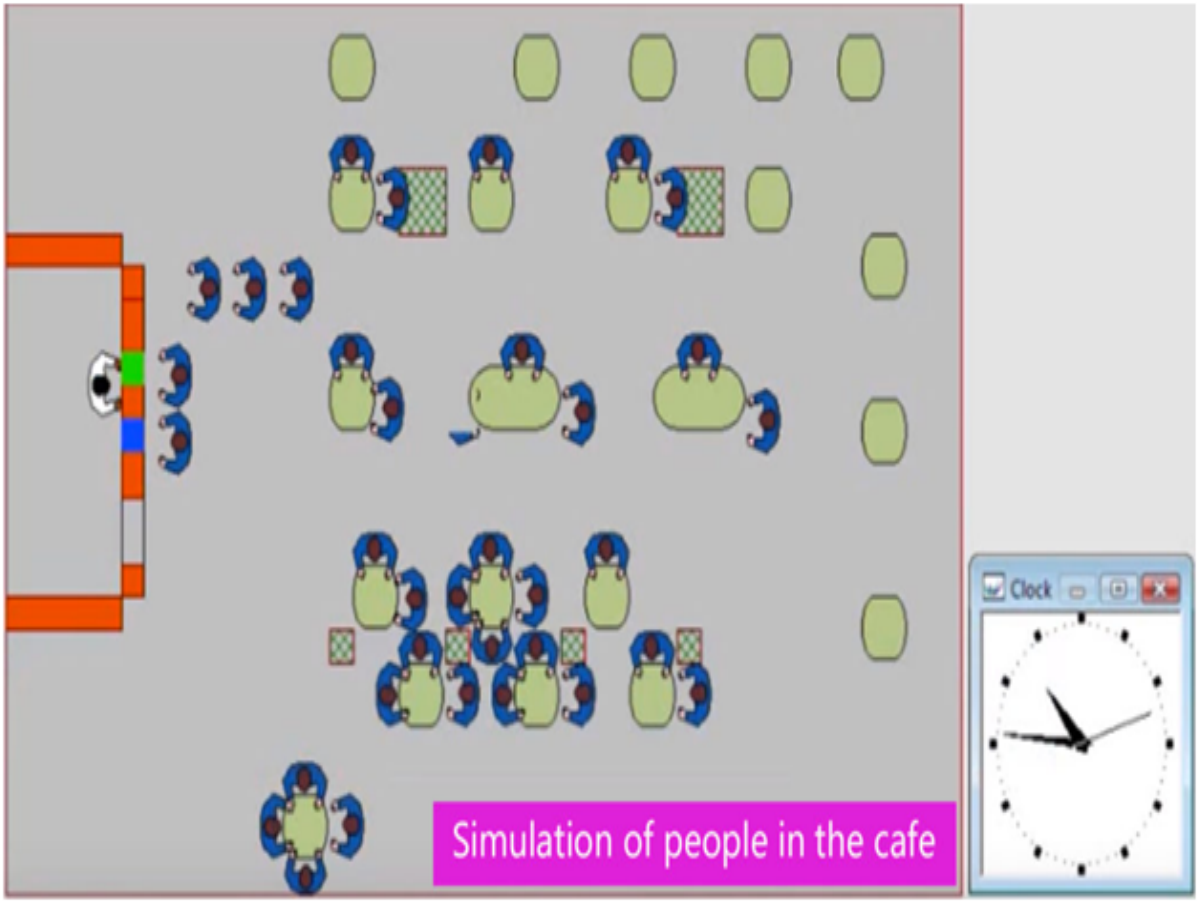

SIMULATION

Definition

According to ***Shannon*** *A Simulation is the process of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behaviour for the operation of the system.*

Definition

According to ***Donald G.Malcolm*** *A simulated model may be defined as one which depicts the working of a large-scale system of men, machine, materials and information operating over a period of time in a simulated environment of the actual real world conditions.*

TYPES OF SIMULATION

Simulation are of two types. Namely 1. **Analogue or Environmental Simulation** and 2.**Computer or System Simulation**

- Analogue simulation is one which simulates the reality in physical form. Some of the examples are Children cycling park, Planetarium,Chess.
- Computer or System Simulation is a numerical technique involving mathematical and logical relationship using digital computer for conducting experiment which involve complex real world system and intricate problem of managerial decision making where analogue type cannot be implemented.

CLASSIFICATION OF SIMULATION MODELS

Simulation models can be classified into the following four categories:

- 1. **Simulation of Deterministic Models**. In the case of these models, the input and output variables are not permitted to be random variable and models are described by exact functional relationship.
- 2.**Simulation of Probabilistic Models.** In such cases, method of random sampling is used. The technique used for solving these models is termed as **Monte-Carlo Technique**.
- 3.**Simulation of Static Models** These models do not take variable time into consideration.
- 4. **Simulation of Dynamic Models** These models deal with time-varying interaction.

METHODOLOGY OF SIMULATION

The following seven steps are involved in Simulation process.

- 1. Identity and clearly define the problem.
- 2. List the statement of objectives of the problem.
- 3. Formulate the variables that influence the situation and an exact or probabilistic description of their possible values or states.
- 4. Obtain a consistent set of values or states for the variables, that is, a sample of what could happen. In the case of deterministic variables, this is simple and in case of probabilistic variables, random sampling technique may be used.
- 5. Use the sample obtained in step 2 to calculate the value of the decision criterion, by actually following the relationships among the variables for each of the alternatives decisions.
- 6. Repeat steps 2 and 3 until a sufficient number of samples are available.
- 7. Tabulate the various values of the decision criterion and choose the best policy.

WHEN TO USE SIMULATION

Simulation may be used especially when

- 1.The problem is susceptible to description by a mathematical model but the analysis of the model is beyond the level of mathematical sophistication of the analyst.
- 2. The problem is not susceptible to description by a mathematical model.

ADVANTAGES OF SIMULATION

Simulation is the process of experimenting on the model rather than on the operation for which the model represents.The following are some of the advantages of simulation:

- 1.Simulation enables us to asses the possible risks involved in a new policy before actually implementing it.
- 2.Simulation methods are easier to apply then pure analytical methods and less time consuming.
- 3.Simulation of complicated systems helps us to locate which variables have the important influences on system performance.
- 4. The knowledge of a system obtained in designing and conducting the simulation is very valuable and can be used for training purposes.
- 5. Simulation is flexible and less time consuming.

LIMITATIONS OF SIMULATION

- 1. Simulation generates a way of evaluating solution but it does not generates the solution technique.
- 2. Quantification of the variables may be difficult.
- 3. Large number of variables makes simulation unwieldy and difficult.
- 4. Simulation may not yield optimum results as it is the trial-and -error approach.

PHASES OF SIMULATION MODEL

A Simulation model consists of two basic phases :

- Phase I : Data Generation - Data generation involves the sample observation of variables and can be carried out with the help of any of the following methods : (i) using random numbers, (ii) resorting to mechanical devices, and (ii) using electronic computers.
- Phase II : Book Keeping - The book-keeping phase of a simulation model deals with updating the system when new events occur, monitoring and recording the system states as and when they change,and keeping track if quantities of our interest such as idle time and waiting time to compute the measures of effectiveness.

GENERATION OF RANDOM NUMBERS

Random numbers play a vital role in simulation models. Random numbers may be drawn from random number table stored in the memory of the computer. A simulation model need not be a deterministic and may include some elements of uncertainty. The problem concerned with probabilistic in simulation, is based on the use of random numbers. These random numbers which have equal probability of being generated. For example,when we are interested in one digit number $0, 1, 2, , , , , , 9$, there are in all ten numbers and each of the numbers should have probability of being generated. There are several methods for the generation of random numbers, the most common among these are the "Mid-square", " Spinning arrow method" "Dice rolling method.

MONTE-CARLO METHOD OF SIMULATION

The Monte-Carlo method is a simulation technique in which statistical distribution function are created by using a series of random numbers.This approach has the ability to develop many months or years of data in a matter of a few minutes on a digital computer. The method is generally used to solve problems which cannot be adequately represented by the mathematical models, or, where solution of the models is not possible by analytical methods. This method yields a solution which should be very close to the optimal but not necessarily the exact solution.

PROCEDURE OF MONTE-CARLO METHOD OF SIMULATION

The Monte-Carlo Simulation procedure can summarized in the following steps:

- Step 1. Define the problem: (a) Identify the objectives of the problem and (b) Identify the factors which have the greatest effect on the objectives of the problem.
- Step 2. Construct an appropriate model: (a) Specify the variables and parameters of the model.
  (b) Formulate the appropriate decision rules, i.e, state the conditions under which the experiment is to be performed,
  (c) Identify the type of distribution that will be used in models either theoretical distributions or empirical distribution to state the patterns of occurrence associated with the variables.
  (d) Specify the manner in which time will change.
  (e) Define the relationship between the variables and parameters.

PROCEDURE OF MONTE-CARLO METHOD OF SIMULATION

- Step 3. Prepare the model for experimentation : (a) Define the starting conditions for the situation, and (b) Specify the numbers of runs of simulation to be made.
- Step 4. Using Step 1 to 3, experiment with the model: (a) Define a coding system that will correlate the factors defined in step 1 with the random numbers to be generated for the simulation.
  (b) Select a random number generator and create the random numbers to be used in the simulation.
  (c) Associate the generated random numbers with the factors identified in step 1 and coded in step $4(a)$.
- Step 5. Summarize and examine the results obtained in step 4.
- Step 6. Evaluate the results of the simulation and select the best course of action.

APPLICATION OF SIMULATION

There is a wide range of applications of computer-based simulation models because it is an approach rather than an application of specific techniques. The major use of computer-based Monte-Carlo simulation model has been in the solution of complex problems. Some of the major application are:

- 1 Queuing problems.
- 2 Inventory problems.
- 3 Training programmes.
- 4 Network problems (PERT).
- 5 Job Sequencing.
- 6 Capital budgeting and investment problems.

APPLICATION OF SIMULATION

- 7 Military studies of logistics, support planning and weapon system and effectiveness.
- 8 Studies of individual and group behaviour.
- 9 Financial studies involving risks investment.
- 10 Testing of decision rules for hospital admission and operating policies.
- 11 Carpet cutting application.
- 12 Public school planning application.