International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 09 | Sep 2019 www.irjet.net p-ISSN: 2395-0072

A Comprehensive Outline of the Types of Simulation

Sadayapillai Kameswaran Sachin[1]

[1]*Student, Department of Production Engineering, National Institute of Technology, Tiruchirappalli, India*

Abstract- *Simulation is the process of imitating a real-life model and solving problems associated with it without interacting with the real-world system. Advantage of simulation is that it can involve difficulties associated with the real system and solve the complication corresponding to it without interacting with the real model. The biggest drawback of simulation is that it involves dealing with cumbersome amount of data, requires highly proficient workers to operate the simulation software and the data output is highly unreliable as it involves lot of uncertainty and randomness. The purpose of this paper is to give a comprehensive run-through of different types of simulation. The crucial objective is to give a holistic outline of one specific kind of simulation i.e. Stochastic simulation where uncertainties are involved. The following paper introduces the types of simulation, terminologies used in monte-carlo and discrete event simulation and finally concludes with a sample problem of monte-carlo simulation.*

Keywords: *simulation, monte-carlo simulation, randomness, uncertainty, modelling.*

1. INTRODUCTION

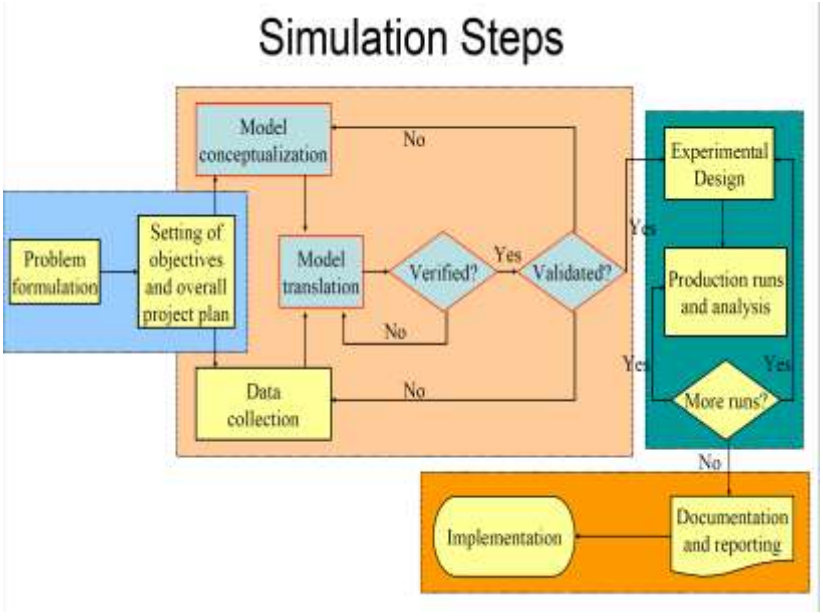

Fig 1.0 Steps involved in simulation

A simulation is a rough imitation of the operation of a process or system the act of simulating first involves a model to be developed. This model is a distinct description of the simulated subject, and represents its significant features, such as its behavior, functions and abstract or physical properties. The model represents the system itself, whereas the simulation represents its operation over time. Simulation is used in many contexts, such as simulation of technology for performance optimization, safety engineering, testing, training, education, and video games. Often, computer experiments are used to study simulation models. Simulation is also used with scientific modelling of natural systems or human systems to gain insight into their functioning as in economics. Simulation can be used to show the eventual real effects of alternative conditions and courses of action. Simulation is also used when the real system cannot be engaged, because it may not be accessible, or it may be dangerous or unacceptable to engage, or it is being designed but not yet built, or it may simply not exist. Important issues in simulation include the procurement of valid source information about the relevant selection of key characteristics and behaviors, the use of simplifying approximations and assumptions within the simulation, and fidelity and validity of the simulation outcomes. Procedures and protocols for model verification and validation are an ongoing field of academic study, refinement, research and development in simulations technology or practice, particularly in the field of computer simulation.

2. TYPES OF SIMULATION

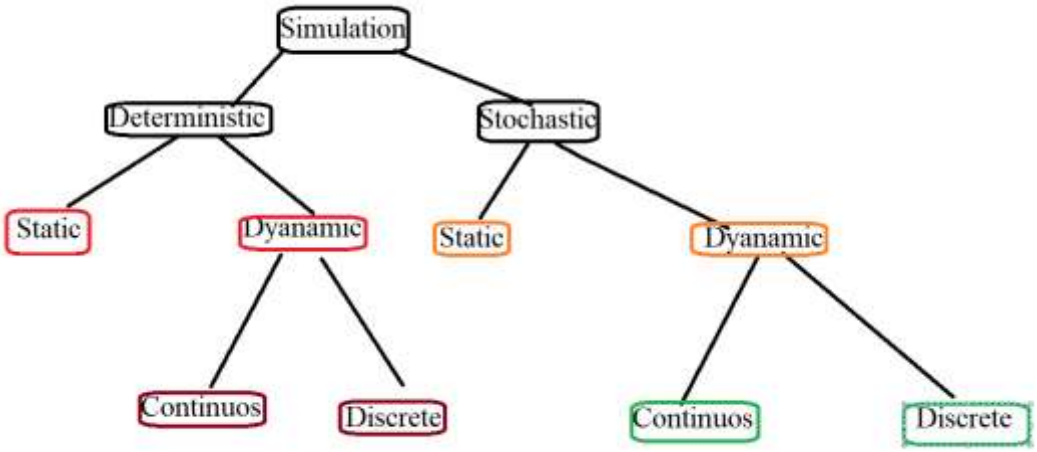

Fig 2.0 Types of simulation

2.1 Deterministic Simulation

In this type of simulation there are no random variables involved and the simulation uses the objective function and set of algorithms to arrive at an answer which is a fixed value as there is no randomness involved. Also when time is considered a parameter then it can be divided in to static simulation where time based average mechanism is used or dynamic simulation where every performance parameter is measured at every time where an event occurs. Dynamic is further divided in to continuous and discrete.

2.2 Stochastic Simulation.

2In this type of simulation there are random variables involved and the simulation uses the objective function and set of algorithms to arrive at an answer and after that randomness is introduced in the system to evaluate the output performance parameters. It is further divided in to subtypes where random number is either discrete or a continuous value. Also, when time is considered a parameter then it can be divided in to static simulation where time based average mechanism is used or dynamic simulation where every performance parameter is measured at every time where an event occurs. Static Stochastic simulation is called monte-carlo simulation where time is static and output parameters are not measured with respect to time. Discrete simulation in dynamic is called discrete event dynamic simulation where performance indicators are measured whenever an event occurs. At every event various parameters are calculated and displayed.

3. TERMINOLOGIES USED IN MONTE-CARLO SIMULATION (STATIC-STOCHASTIC).

3.1 Entity

Every entity or an individual in a system is called entity. For eg in a hospital patient is an entity.

3.2 System

All the entities combined and interacting to perform a particular action is called system.

3.3 State variables

They indicate the state of the system for e.g. In a hospital arrival time, service time, waiting time are all state variables which give an idea on the performance of the system.

3.4 Event

Event changes the state of the system. For e.g. arrival of customer changes state of server from idle to busy.

3.5 Attribute

It is the characteristic of each of the entity in the system. For e.g. amount of food a person can eat is an attribute of the person etc.

3.6 Activity

Actions performed by the entity in the system.

4. TERMINOLOGIES USED IN DISCRETE EVENT SIMULATION (DYNAMIC STOCHASTIC).

4.1 Simulation clock: A variable giving the current value of simulated time. Unit of time is assumed to be same as unit of input parameters

4.2 List/set: A collection of associated entities ordered in some logical fashion e.g. In an outpatient clinic a set might include the patience waiting for service ordered by severity of disorder or first come first serve

4.3 Event notice: A record of an event to occur at the current or future time along with associated data to execute the event.

4.4 Event List/Future Event List: A list of event notices for future events ordered by time of occurrence

4.5 Activity: A duration of time of specified length which is known when it begins e.g. Arrival, Service time

4.6 Delay: A duration of time of unspecified length which is not known until it ends e.g. waiting time in queue

4.7 Statistical counters: Variables used for storing statistical information about the system performance

4.8 Time advance mechanism: Generally used mechanism is next event time advance mechanism where the simulation clock is moved to the time when an event is going to take place.

5. EXAMPLE OF MONTE-CARLO SIMULATION WITH A SAMPLE PROBLEM.

Arrival and service follow Poisson and exponential distribution respectively and they have following probabilities as shown below. The problem asks to find average waiting time per customer.

Arrival random no's: 87,32,70,14,10,32,50,89,84

Service time random no's: 15,40,20,70,89,97,46,10

Arrival Probability

Time between arrivals(min)	Probability	Cumlative probability	Random No interval			
1	0.25	0.25	01--25			
2	0.4	0.65	26--65			
3	0.2	0.85	66--85			
4	0.15	1	86--00			

Table 1.0

Service time probability

Service time(min)	Probability	Cumlative probability	Random No interval			
2	0.3	0.3	01--30			
3	0.25	0.55	31--55			
4	0.25	0.8	56--80			
5	0.2	1	81--00			

Table 2.0

Customer no	Time b/w arrival	arrival time	Service time	Service begins	Service ends	waiting time
1	4	4	2	4	6	0
2	2	6	3	6	9	0
3	3	9	2	9	11	0
4	1	10	4	11	15	1
5	2	12	5	15	20	3
6	2	14	5	20	25	6
7	4	18	3	25	28	7
8	3	21	2	28	30	7
					waiting time	24

Table 3.0

From table 3.0 we see that simulation is performed for an arrival of 8 customers using probability distribution and random numbers.

Performance parameters

- The waiting time is found to be = **24 minutes.**
- Average waiting time/ customer= **24/8** = **3minutes/ customer**
- Probability to wait = **5/8= 0.63** as 5 out of 8 customers have to wait in queue.

6. CONCLUSION

In this paper simulation was defined and the different types of simulation were discussed. The stochastic simulation was focused in depth and one subtype monte-carlo (static-stochastic) was explored in detail along with the terminologies used in monte-carlo and discrete event simulation. Simulation is a very important aspect of industrial engineering which seeks to

resolve the difficulties faced by people in the real world by building a simulation model of the real system and analyses how the system would perform with or without uncertainty in the real system. One major with simulation is that it involves analyzing huge chunks of data and data gathered is usually unreliable because of the randomness involved. The future scope is to reduce the amount of data to be analyzed to come to a conclusion about simulation system performance and to reduce the cumbersomeness of simulation models.

REFERENCES

[1] https://www.techopedia.com/definition/5757/simulation

[2] https://en.wikipedia.org/wiki/Stochastic_simulation

[3] https://en.wikipedia.org/wiki/Deterministic_simulation

[4] https://en.wikipedia.org/wiki/Monte_Carlo_method

[5] https://en.wikipedia.org/wiki/Discrete-event_simulation

[6] C. Rausch, M. Nahangi, C. Haas, W. Liang," Monte Carlo simulation for tolerance analysis in prefabrication and offsite construction", Automation in construction, Vol. 103, July 2019, pp. 300-314.

BIOGRAPHY

Sadayapillai Kameswaran Sachin is an aspiring industrial engineer, who is currently studying production engineering (4th year Btech) at National institute of technology, Tiruchirappalli, India. His research interests are unconventional manufacturing processes, supply chain &logistics, lean manufacturing and industrial engineering.