Chapter 1

Introductory Chapter: Computer Simulation

Dragan Cvetković

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.84198

1. Introduction

Information technologies have changed people's lives to a great extent, so it is almost impossible to imagine any activity which does not depend on computers. Once the first computer systems appeared, people were trying to take advantage of computers in order to solve complex problems in various areas. With the development of industry, demands for computers and computational programs in structural analysis have evolved. Traditional methods of constructing are replaced by computer programs that have the ability to predict the behavior of structures under different load conditions [1, 2]. Thus, expensive experiments, tests, and examinations are substituted by cheaper and more powerful computational methods that do not require the destruction of the structure itself in order to determine its capacity.

1.1. Process of modeling and making of reliable computer model

Computer programs help in solving this kind of problems. Firstly, the simulation of the real system should be made, and after that, if the simulation gives satisfactory results, realization of previously examined system can be carried out. Computer simulation or a computer model has the task to simulate an abstract model of a particular or equivalent system. Computer simulations have become a useful part of mathematical modeling of many natural systems in physics, mechanics, chemistry, biology, economic systems, psychology, and social sciences, as well as in all branches of engineering, in order to gain a better insight into the work of previously mentioned systems [1, 3, 4].

In order to have a useful model, it is necessary to determine its behavior for defined and limited set of variables. This means that for some random input parameters are observed corresponding output values.

1.2. Computer modeling and computer simulation

Simulation in everyday life can be related to various activities. If this word is used in the computer technology, then the term simulation represents the process of creating the abstract system models from the real environment and carrying out the appropriate number of experiments on them. When the experiments are carried out on a computer, then they are named computer modeling and computer simulation (**Figure 1**).

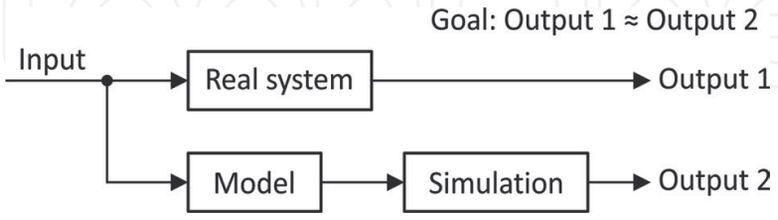

Figure 1. Link between real system modeling and computer simulation.

The input data vary and depend on many factors when the models and simulations are taken into consideration. For example, some models require very simple inputs (e.g., the input for the simulation of an AC sinusoid is based on few numbers), while other models require terabytes of input data (e.g., simulation of weather or climate changes).

Input data are provided by various devices which are:

- Sensors and other physical devices that are connected to the model
- Control panel that directly affect the progress of the simulation itself in some way
- Current or older data brought in manually
- The values that represent the output products from other processes or operations
- Values that represent output elements of other models or simulations

It should be noted that the systems that receive data from external sources must be "careful": they should know what these data represent and to which elements are actually connected. The precision must be taken into account and the errors should not occur. If the errors appear, they should be reduced to the minimum. The mathematics integrated in the computer is not perfect, so the approximate results, result abbreviations, or neutralization of small errors can lead to an increase of potential errors. It is necessary, in some cases, to analyze the resulting error in order to verify that the simulation output is valid and that it can be used in further calculations and simulations. Even small errors in the original input data can accumulate in significant errors in further simulations [1, 4, 5].

1.3. Why do we need computer modeling and computer simulations?

What do we use modeling and simulation for? Are they necessary? These questions are asked very often, and there are plenty of reasons for their creation and usage, and the most important are the following ones:

- It is impossible to determine the analytical solution of the analytical model.
- The system is too complex and it is impossible to describe it analytically.
- The experiment within a real system or the experiment on the real system is, in most cases, either unprofitable or too complex. Modeling and simulation can show whether a further investment in the experiment is justified or not.
- Often the aim of modeling and simulation is to perceive the functionality of the existing real system, whose structure is barely known or cannot be approached to.
- When the optimal or optimized functioning of a system is needed, it is necessary to change various parameters. If the real system is taken into account, this is often impossible because there is no such a system. In other words, that kind of a system has not been built yet, or the prices of such an experiment are excessive. In such situations, modeling and simulation are the best solutions.
- Sometimes it is necessary to simulate the conditions that lead to the destruction of the system. The destruction of the real system, in most cases, is not allowed, so the computer simulation, in such situations, is the only solution.
- When it comes to long-term processes of real system or within the real system, then time can be a problematic factor. In such situations, computer simulation can "accelerate" the process and shorten it artificially.
- When it comes to extremely fast processes of the real system or within the real system, computer simulation is a solution which allows the monitoring of high-speed processes gradually or slowly. This is very important, since it is not possible in real life or in real environment.
- Sometimes the experiment should be stopped for various reasons, and it is often impossible in real terms. When it comes to computer simulation of such an experiment, there is no problem, because the simulation can be stopped and continued when it is necessary.

1.4. Advantages and disadvantages of computer simulations

Like everything in life, computer simulations are not perfect and there are different problems. Simulations are, generally speaking, very useful, but they have advantages as well as disadvantages. The basic advantages of computer simulations are:

- When a model is created, then it can be used repeatedly for the analysis of required process, structures, and similar elements.
- Computer simulations can be extremely helpful, even if the input data are incomplete and with a certain amount of arbitrariness.
- In most cases it is easier and cheaper to get the output data of the simulation than the output data of the real system.
- Computer simulation generates the necessary data that can be used for the evaluation and assessment of any system characteristic and without big restrictions.

- In some cases, the computer simulation may be the only way to resolve the problems appropriately.
- Computer simulation can describe and solve complex problems by using dynamic random variables, which are unavailable in mathematical modeling.

The major disadvantages of computer simulations are:

- Making of simulation models as well as computer simulations can be expensive and time consuming (it refers to the time needed for their development, testing, and verification).
- By using computer simulations, neither the relation between output and input variables nor optimal solutions can be obtained.
- Knowledge of different tools and methods is required for the development and use of simulation models and computer simulations as well.
- Model evaluation is quite a complex process and requires additional experimentation in different environments.

No matter what, computer simulation is a very useful thing, and its use is rapidly increasing in environments and situations where it is possible. Obviously, the application of computer simulation has many more advantages than disadvantages, and it is certain that computer simulations are going to be dominant in almost every area and environment of everyday life [4, 6].

Author details

Dragan Cvetković

Address all correspondence to: dcvetkovic@singidunum.ac.rs

Faculty of Informatics and Computing, Singidunum University, Belgrade, Republic of Serbia

References

[1] Steinhauser MO. Computer Simulation in Physics and Engineering. Berlin: De Gruyter; 2012

[2] Mityushev V, Nawalaniec W, Rylko N. Introduction to Mathematical Modeling and Computer Simulation. 1st ed. USA: Chapman and Hall/CRC; 2018

[3] Goldman R. An Integrated Introduction to Computer Graphics and Geometric Modeling. 1st ed. USA: CRC Press; 2009

[4] Law AM. Simulation Modeling and Analysis. 5th ed. USA: McGraw-Hill Education; 2014

[5] Zeigler B, Muzy A, Kofman E. Theory of Modeling and Simulation—Discrete Event & Iterative System Computational Foundations. USA: Academic Press; 2018

[6] Shiflet AB, Shiflet GW. Introduction to Computational Science: Modeling and Simulation for the Sciences. 2nd ed. USA: Princeton University Press; 2014