# A Review of Simulation Techniques as an Important Tool for Solving Complex Problems

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**Abstract**— The use of a simulation software allows us to perform studies of complicated systems whose analytic solution is not known or whose experiment cannot be performed in actual system. A simulated model has to be prepared describing the interaction between elements of the system. After preparing the model random number generation takes place. Simulated model is run with the help of random numbers. Simulation basically involves conducting experiments on the model of the system. With the help of simulation software like ARENA, AUTOCAST, SIMPY, ELMER etc. simulation becomes a vital tool for solving complex problems.

**Index Terms** — Arena, modeling, robotic simulation, System simulation, Simulators, Optimization.

## 1 INTRODUCTION

A simulation is the imitation of the operation of a real-world process or system over time. Whether it is done by hand or a computer, simulation involves the generation an artificial history to draw inference concerning the operating characteristics of the real system [1]. This technique is widely used in manufacturing industry, service industry, automobile industry, aircraft manufacturing and testing industry, video games, health care, military training etc. Based on the well developed statistical theories, simulation effectively deals with the unforeseen uncertainties in any system. With the advent of many user friendly simulation software, simulation is gaining ever increasing importance for solving complex problems.

### 2.1 Simulation Techniques for Solving Supply Chain Management Problems

Supply chain consists of all the stages in fulfilling a customer Request [2]. These are to supply, manufacture, and retail, as well as to transport, warehouse, and distribute. Each product should pass through all these stages in order to be available to the end-consumer [3]. Delivery lead time is one of the main factors that affects supply chain performance and makes the planning process more complex. Lead time is defined as the time interval between placing an order and its reception. Based on this definition, lead time is composed of various parts including (1) information delays in receiving an order by the upstream, (2) time of order processing by the upstream, and (3) transportation time [3].S. Kamal Chaharsooghi and Jafar Heydar prepared a simulation model using MATLAB and Using canonical correlation, they show that the effect of Lead Time variance on Suply Chain performance is much greater than effect of the Lead Time mean.

### 2.2 Simulation Techniques for Solving Sound and Vibration Problems

An important field of work in many industrial and practical acoustical applications is the design of cells for the control of noise in open or closed enclosures. Obviously, these cells should include some passive method for sound absorption, but it is well known that the use of these kind of methods in the low frequency range is inefficient because large sizes and/or weights of bulky sound-absorbing materials would be required to achieve acceptable performances [4]A. Bermu´dez,P. Gamallo, L. Hervella-Nieto,A. Prieto in 2010 performed Numerical simulation of passive–active cells with Micro-perforated plates or porous veils. It allows evaluation of the acoustic attenuation

### 2.3 Simulation Techniques for Solving Aerodynamic Heating Problems of High Speed Vehicle-

High speed vehicles are designed to withstand severe aerodynamic heating conditions. Such vehicles include hypervelocity projectiles, re-entry vehicles and hyper-sonic aircraft. Maximum heating and the consequent potential for material erosion are a typical problem associated with the nose-region of the blunt body. Several techniques have been developed with the target of significantly reducing the aerodynamic drag of blunt nose cones. M. Barzegar Gerdroodbary andS.M. Hosseinalipour in2010 performed Numerical simulation of hypersonic flow over highly blunted cones with spike and obtained some good results for this heating problems.

### 2.4 Simulation in Education and Training

Simulation is extensively used for educational purposes. Simulation is often used in the training of civilian and military personnel when it is prohibitively expensive or simply too dangerous to allow trainees to use the real equipment in the

real world. In such situations they will spend time learning valuable lessons in a "safe" virtual environment.

### 2.5 Clinical Healthcare Simulator

Medical simulators are increasingly being developed to teach therapeutic and diagnostic procedures as well as medical concepts and decision making to personnel in the health professions. Simulators have been developed for training procedures ranging from the basics such as blood draw .They are also important to help on prototyping new devices for biomedical engineering problems. Currently, simulators are applied to research and develop tools for new therapies.

### 2.6 Simulation in Entertainment

Simulation encompasses many large and popular industries such as film, television ,video games and rides in theme parks. Advances in technology in the 1990s and 2000s caused simulation to become more widely used and it began to appear in movies such as Jurassic Park (1993) and in computer-based games such as Age of empires.

### 2.7 Simulation in Manufacturing Industry

Manufacturing represents one of the most important applications of Simulation. This technique represents a valuable tool used by engineers when evaluating the effect of capital investment in equipments and physical facilities like factory plants, warehouses, and distribution centers. Simulation can be used to predict the performance of an existing or planned system and to compare alternative solutions for a particular design problem. Another important goal of manufacturing-simulations is to quantify system performance. Common measures of system performance include the following.

- Throughput under average and peak loads;
- System cycle time (how long it take to produce one part);
- Utilization of resource, labor, and machines;
- Bottlenecks and choke points;
- Queuing at work locations;
- Queuing and delays caused by material-handling de vices and systems;
- WIP storages needs;
- Staffing requirements;
- Effectiveness of scheduling systems;
- Effectiveness of control systems.

### 2.8 Disaster Preparedness and Simulation Training

Simulation training has become a method for preparing people for disasters. Simulations can replicate emergency situations and track how learners respond to a lifelike experience. Disaster preparedness simulations can involve training on how to handle terrorism attacks, natural disasters, pandemic outbreaks, or other life-threatening emergencies. One organization that has used simulation training for disaster preparedness is CADE (Center for Advancement of Distance Education). CADE has used a video game to prepare emergency workers for multiple types of attacks. As reported by News-Medical.Net, The video game is the first in a series of simulations to address bioterrorism, pandemic flu, smallpox and other disasters that emergency personnel must prepare for. Developed by a team from the University of Illinois at Chicago (UIC), the game allows learners to practice their emergency skills in a safe, controlled environment.

### 2.9 Engineering, Technology or Process Simulation

Simulation is an important feature in engineering systems or any system that involves many processes. For example in electrical engineering, delay lines may be used to simulate propagation delay and phase shift caused by an actual transmission line. Similarly, dummy loads may be used to simulate impedance without simulating propagation, and is used in situations where propagation is unwanted. Most engineering simulations entail mathematical modeling and computer assisted investigation. There are many cases, however, where mathematical modeling is not reliable. Simulation of fluid dynamics problems often requires both mathematical and physical simulations. In these cases the physical models require dynamic similitude. Physical and chemical simulations have also direct realistic uses, rather than research uses; in chemical engineering, for example, process simulations are used to give the process parameters immediately used for operating chemical plants, such as oil refineries.

### 2.10 Ergonomics Simulation

Ergonomic simulation involves the analysis of virtual products or manual tasks within a virtual environment. In the engineering process, the aim of ergonomics is to develop and to improve the design of products and work environments. Ergonomic simulation utilizes an anthropometric virtual representation of the human, commonly referenced as a mannequin or Digital Human Models (DHMs), to mimic the postures, mechanical loads, and performance of a human operator in a simulated environment such as an airplane, automobile, or manufacturing facility. DHMs are recognized as evolving and valuable tool for performing proactive ergonomics analysis and design. The simulations employ 3D-graphics and physics-based models to animate the virtual humans. Er-

gonomics software uses inverse kinematics (IK) capability for posing the DHMs. Several ergonomic simulation tools have been developed including Jack, SAFEWORK, RAMSIS, and SAMMIE.

### 2.11 Flight Simulation

Flight Simulation Training Devices (FSTD) are used to train pilots on the ground. In comparison to training in an actual aircraft, simulation based training allows for the training of maneuvers or situations that may be impractical (or even dangerous) to perform in the aircraft, while keeping the pilot and instructor in a relatively low-risk environment on the ground. For example, electrical system failures, instrument failures, hydraulic system failures, and even flight control failures can be simulated without risk to the pilots or an aircraft. Instructors can also provide students with a higher concentration of training tasks in a given period of time than is usually possible in the aircraft. For example, conducting multiple instrument approaches in the actual aircraft may require significant time spent repositioning the aircraft, while in a simulation, as soon as one approach has been completed, the instructor can immediately preposition the simulated aircraft to an ideal (or less than ideal) location from which to begin the next approach. Flight simulation also provides an economic advantage over training in an actual aircraft. Once fuel, maintenance, and insurance costs are taken into account, the operating costs of an FSTD are usually substantially lower than the operating costs of the simulated aircraft. For some large transport category airplanes, the operating costs may be several times lower for the FSTD than the actual aircraft.

### 2.12 Military Simulations

Military simulations, also known informally as war games, are models in which theories of warfare can be tested and refined without the need for actual hostilities. They exist in many different forms, with varying degrees of realism. In recent times, their scope has widened to include not only military but also political and social factors

### 2.13 Project Management Simulation

Project management simulation is simulation used for project management training and analysis. It is often used as training simulation for project managers. In other cases it is used for what-if analysis and for supporting decision-making in real projects. Frequently the simulation is conducted using software tools.

### 2.14 Robotics Simulators

A robotics simulator is used to create embedded applications for a specific (or not) robot without being dependent on the 'real' robot. In some cases, these applications can be transferred to the real robot (or rebuilt) without modifications. Robotics simulators allow reproducing situations that cannot be 'created' in the real world because of cost, time, or the 'uniqueness' of a resource. A simulator also allows fast robot prototyping. Many robot simulators feature physics engines to simulate a robot's dynamics.

### 2.15 Weather Simulation

Predicting weather conditions by extrapolating/interpolating previous data is one of the real use of simulation. Most of the weather forecasts use this information published by Weather bureaus. This kind of simulations help in predicting and forewarning about extreme weather conditions like the path of an active hurricane/cyclone. Numerical weather prediction for forecasting involves complicated numeric computer models to predict weather accurately by taking many parameters into account.

### 2.16 Simulation in Nano-Electronic Devices

The miniaturization of nano-scale electronic devices, such as metal oxide semiconductor field effect transistors (MOSFETs), has given rise to a pressing demand in the new theoret-ical understanding and practical tactic for dealingwith quantummechanical effects in inte-grated circuits. Modeling and simulation of this class of problems have emerged as an important topic in applied and computational mathematics [6]. Duan Chen and Guo-Wei Wei in 2009 performed Modeling and simulation of electronic structure, material interface and random doping in nano-electronic devices and they proposed a new individual dopant model that utilizes the Dirac delta function to understand the random doping effect in nano-electronic devices.

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