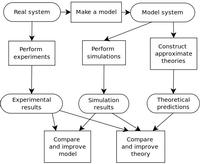
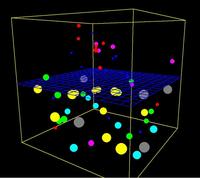
Computer Simulation

**Full Text**

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*Computer simulation* is the use of computer technology to make digital models that represent real-world elements, behaviors, and systems. Programmers and engineers can then use the computerized model in experiments, changing conditions and observing the effects on the model. By observing and analyzing the results of these experiments, people can draw inferences about how the elements might behave in the real world. Testing a simulated model instead of a real-life object or scenario is generally much safer and less expensive, though simulated tests may prove to be less accurate. A type of [applied mathematics](https://eds.s.ebscohost.com/eds/detail/detail?sid=0adba510-e0c8-403c-95c9-febbdb8bbd17@redis&vid=11&db=ers&ss=AN+%2289250357%22&sl=ll), computer simulation is commonly used for a wide variety of purposes in fields such as science, politics, military studies, and entertainment.

Process of building a computer model, and the interplay between experiment, simulation, and theory. By Danski14 (Own work) [CC BY-SA 3.0 (http://creativecommons.org/licenses/by-sa/3.0)], via Wikimedia CommonsComputer simulation of the process of osmosis By Lazarus666 at en.wikipedia (Transferred from en.wikipedia) [FAL, GFDL (www.gnu.org/copyleft/fdl.html) or CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0/)], from Wikimedia Commons

**Uses and Types**

To perform a computer simulation, operators design a digital model of something to be tested. For instance, engineers may want to explore the feasibility of a new bridge linking two cities. In this case, operators program data about the proposed bridge—such as its dimensions, weight, construction style, and materials—into an appropriate simulation program. Other factors, such as the location, climate, water flow, and typical wind speed, are programmed as well to complete the simulated scenario.

Once the simulation begins, the program shows how the proposed bridge would likely fare in the prevailing conditions. If engineers need specific information, such as how a tornado would affect the bridge, they can manipulate the data to reflect tornado-speed winds. They may also want to test different designs for the bridge, and may program different sizes or styles of bridge to test which works best in the given circumstances.

The simulation may run once or many times, and may be programmed to reflect a short time or a single event or potentially countless times or events. Operators study the data gathered by each simulation to help them gain better understanding of the dynamics of the system they have designed. Scientists with large quantities of data usually use statistics or other means of interpreting their findings, especially since simulations may not accurately reflect real-world possibilities.

People may use computer simulations to test proposed systems for many reasons. Sometimes the system being studied does not exist in the real world and cannot be easily or safely created, or may even be impossible to create. Sometimes a system does exist but operators want to simulate proposed changes to the system without actually altering the system in real life, which might involve serious expenses or dangers. In other cases, the simulation tests systems that have not occurred but may occur in the future—some examples of this are forecasting weather or predicting the spread of populations or diseases across a given area. Other simulations may test physical structures, economic principles, workplace practices, biological systems, or social trends.

There are three major kinds of computer simulations: continuous, Monte Carlo, and discrete. *Continuous simulations* show results of a system over time, with equations designed to show progressive changes. [Monte Carlo simulations](https://eds.s.ebscohost.com/eds/detail/detail?sid=0adba510-e0c8-403c-95c9-febbdb8bbd17@redis&vid=11&db=ers&ss=AN+%2289317099%22&sl=ll) use random numbers and random events without regard for time. Finally, *discrete simulations* (sometimes classified as a subtype of Monte Carlo simulations) involve occasional events that break up otherwise uneventful blocks of time.

**Development and Modern Importance**

Although computer simulations are a relatively modern science, only arising after the dawn of the computer age in the twentieth century, the history of simulation reaches into ancient times. Before advanced science and technology were available to provide some accuracy to simulated results, people used mystical means to try to divine details of the future or hypothetical situations. Astrologers, oracles, prophets, and sorcerers were sought after in many lands for their purported abilities to gather information inaccessible to most.

As advances in science and technology replaced mysticism, people began creating computer programs that would use mathematical and scientific principles to create simulations. Some of the earliest computer-based simulations took place during World War II when scientists such as [John von Neumann](https://eds.s.ebscohost.com/eds/detail/detail?sid=0adba510-e0c8-403c-95c9-febbdb8bbd17@redis&vid=11&db=ers&ss=AN+%2289129815%22&sl=ll) and Stanislaw Ulam used early computerized devices to simulate the effects of atomic bombs. As the primitive computers of the 1940s became faster, stronger, and more reliable, their ability to create simulations developed as well.

Modern computers are able to create comprehensive simulations for a wide range of different fields and applications. Simulation programs give operators more tools to customize the factors of their simulations, alter variables, and create animated digital displays to represent the simulated scenarios. As the efficiency of simulations increases, so too do demands on simulation programmers to make their products more efficient and free of errors.

Computer simulations are generally less costly and difficult to prepare than real-life demonstrations, enabling them to be performed more quickly and frequently, thus creating more usable data. Even the process of creating a simulation could result in benefits for an individual or organization. To design the simulation, operators must painstakingly plan the model, which means analyzing all aspects of the proposed design and sometimes gathering new information from other sources. During this process, flaws in the concept may appear, or new potential approaches may come to light. When the simulation is complete, it is generally easy to customize and modify, allowing operators to use their creativity to explore any different factors or approaches they have identified. In short, making a simulation may be like a trial run of creating a real-life project, and as such help to refine the final design.

At the same time, computer simulations are not without their faults. Complex simulations may require extensive costs for programming, training, software, and data analysis as well as a significant amount of preparation time. Additionally, data resulting from the simulation is inexact, since it only approximately represents possibilities, not real-world happenings. Accepting simulation data as perfectly accurate can lead to serious risks.

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