**More examples of simulation**

An automobile simulator provides an opportunity to reproduce the characteristics of real vehicles in a virtual environment. It replicates the external factors and conditions with which a vehicle interacts enabling a driver to feel as if they are sitting in the cab of their own vehicle. Scenarios and events are replicated with sufficient reality to ensure that drivers become fully immersed in the experience rather than simply viewing it as an educational experience.

The simulator provides a constructive experience for the novice driver and enables more complex exercises to be undertaken by the more mature driver. For novice drivers, truck simulators provide an opportunity to begin their career by applying best practice. For mature drivers, simulation provides the ability to enhance good driving or to detect poor practice and to suggest the necessary steps for remedial action. For companies, it provides an opportunity to educate staff in the driving skills that achieve reduced maintenance costs, improved productivity and, most importantly, to ensure the safety of their actions in all possible situations.

**Biomechanics**

An open-source simulation platform for creating dynamic mechanical models built from combinations of rigid and deformable bodies, joints, constraints, and various force actuators. It is specialized for creating biomechanical models of human anatomical structures, with the intention to study their function and eventually assist in the design and planning of medical treatment.

A biomechanics simulator is used to analyze walking dynamics, study sports performance, simulate surgical procedures, analyze joint loads, design medical devices, and animate human and animal movement.

A neuromechanical simulator that combines biomechanical and biologically realistic neural network simulation. It allows the user to test hypotheses on the neural basis of behavior in a physically accurate 3-D virtual environment.

**City and urban**

A city simulator can be a [city-building game](https://en.wikipedia.org/wiki/City-building_game) but can also be a tool used by urban planners to understand how cities are likely to evolve in response to various policy decisions. [AnyLogic](https://en.wikipedia.org/wiki/AnyLogic%22%20%5Co%20%22AnyLogic) is an example of modern, large-scale urban simulators designed for use by urban planners. City simulators are generally [agent](https://en.wikipedia.org/wiki/Agent_%28economics%29)-based simulations with explicit representations for [land use](https://en.wikipedia.org/wiki/Land_use) and [transportation](https://en.wikipedia.org/wiki/Transportation). [UrbanSim](https://en.wikipedia.org/wiki/UrbanSim%22%20%5Co%20%22UrbanSim) and [LEAM](https://en.wikipedia.org/wiki/Land_Use_Evolution_and_Impact_Assessment_Model) are examples of large-scale urban simulation models that are used by metropolitan planning agencies and military bases for land use and [transportation planning](https://en.wikipedia.org/wiki/Transportation_planning).

**Communication satellites**

Modern satellite communications systems ([SATCOM](https://en.wikipedia.org/wiki/Satcom_%28satellite%29)) are often large and complex with many interacting parts and elements. In addition, the need for broadband connectivity on a moving vehicle has increased dramatically in the past few years for both commercial and military applications. To accurately predict and deliver high quality of service, SATCOM system designers have to factor in terrain as well as atmospheric and meteorological conditions in their planning. To deal with such complexity, system designers and operators increasingly turn towards computer models of their systems to simulate real-world operating conditions and gain insights into usability and requirements prior to final product sign-off. Modeling improves the understanding of the system by enabling the SATCOM system designer or planner to simulate real-world performance by injecting the models with multiple hypothetical atmospheric and environmental conditions. Simulation is often used in the training of civilian and military personnel. This usually occurs 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 yet living a lifelike experience (or at least it is the goal). Often the convenience is to permit mistakes during training for a safety-critical system.

**Digital Lifecycle**

Simulation solutions are being increasingly integrated with CAx (CAD, CAM, CAE....) solutions and processes. The use of simulation throughout the product lifecycle, especially at the earlier concept and design stages, has the potential of providing substantial benefits. These benefits range from direct cost issues such as reduced prototyping and shorter time-to-market to better performing products and higher margins. However, for some companies, simulation has not provided the expected benefits.

The research firm Aberdeen Group has found that nearly all best-in-class manufacturers use simulation early in the design process as compared to 3 or 4 laggards who do not.

The successful use of simulation, early in the lifecycle, has been largely driven by increased integration of simulation tools with the entire CAD, CAM and PLM solution-set. Simulation solutions can now function across the extended enterprise in a [multi-CAD environment](https://en.wikipedia.org/w/index.php?title=NX_5&action=edit&redlink=1), and include solutions for [managing simulation data and processes](https://en.wikipedia.org/wiki/Teamcenter#Simulation_Process_Management) and ensuring that simulation results are made part of the product lifecycle history. The ability to use simulation across the entire lifecycle has been enhanced through improved user interfaces such as [tailorable user interfaces](https://en.wikipedia.org/w/index.php?title=NX_5&action=edit&redlink=1" \o "NX 5 (page does not exist)) and "wizards" which allow all appropriate PLM participants to take part in the simulation process.

**Disaster preparedness**

Simulation training has become a method for preparing people for disasters. Simulations can replicate emergency situations and track how learners respond thanks to a [lifelike experience](https://en.wikipedia.org/wiki/Lifelike_experience). Disaster preparedness simulations can involve training on how to handle [terrorism](https://en.wikipedia.org/wiki/Terrorism) attacks, natural disasters, [pandemic](https://en.wikipedia.org/wiki/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[[67]](https://en.wikipedia.org/wiki/Simulation%22%20%5Cl%20%22cite_note-67) 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.[[68]](https://en.wikipedia.org/wiki/Simulation#cite_note-68)" Developed by a team from the [University of Illinois at Chicago](https://en.wikipedia.org/wiki/University_of_Illinois_at_Chicago) (UIC), the game allows learners to practice their emergency skills in a safe, controlled environment.

The Emergency Simulation Program (ESP) at the British Columbia Institute of Technology (BCIT), Vancouver, British Columbia, Canada is another example of an organization that uses simulation to train for emergency situations. ESP uses simulation to train on the following situations: forest fire fighting, oil or chemical spill response, earthquake response, law enforcement, municipal firefighting, hazardous material handling, military training, and response to terrorist attack[[69]](https://en.wikipedia.org/wiki/Simulation#cite_note-straylightmm.com-69) One feature of the simulation system is the implementation of "Dynamic Run-Time Clock," which allows simulations to run a 'simulated' time frame, "'speeding up' or 'slowing down' time as desired"[[69]](https://en.wikipedia.org/wiki/Simulation#cite_note-straylightmm.com-69) Additionally, the system allows session recordings, picture-icon based navigation, file storage of individual simulations, multimedia components, and launch external applications.

At the University of Québec in Chicoutimi, a research team at the outdoor research and expertise laboratory (Laboratoire d'Expertise et de Recherche en Plein Air – LERPA) specializes in using wilderness backcountry accident simulations to verify emergency response coordination.

Instructionally, the benefits of emergency training through simulations are that learner performance can be tracked through the system. This allows the developer to make adjustments as necessary or alert the educator on topics that may require additional attention. Other advantages are that the learner can be guided or trained on how to respond appropriately before continuing to the next emergency segment—this is an aspect that may not be available in the live environment. Some emergency training simulators also allow for immediate feedback, while other simulations may provide a summary and instruct the learner to engage in the learning topic again.

In a live-emergency situation, emergency responders do not have time to waste. Simulation-training in this environment provides an opportunity for learners to gather as much information as they can and practice their knowledge in a safe environment. They can make mistakes without risk of endangering lives and be given the opportunity to correct their errors to prepare for the real-life emergency.

**Economics**

In [economics](https://en.wikipedia.org/wiki/Economics) and especially [macroeconomics](https://en.wikipedia.org/wiki/Macroeconomics), the effects of proposed policy actions, such as [fiscal policy](https://en.wikipedia.org/wiki/Fiscal_policy) changes or [monetary policy](https://en.wikipedia.org/wiki/Monetary_policy) changes, are simulated to judge their desirability. A mathematical model of the economy, having been fitted to historical economic data, is used as a proxy for the actual economy; proposed values of [government spending](https://en.wikipedia.org/wiki/Government_spending), [taxation](https://en.wikipedia.org/wiki/Taxation), [open market operations](https://en.wikipedia.org/wiki/Open_market_operations), etc. are used as inputs to the simulation of the model, and various variables of interest such as the [inflation rate](https://en.wikipedia.org/wiki/Inflation_rate), the [unemployment rate](https://en.wikipedia.org/wiki/Unemployment_rate), the [balance of trade](https://en.wikipedia.org/wiki/Balance_of_trade) deficit, the government [budget deficit](https://en.wikipedia.org/wiki/Budget_deficit), etc. are the outputs of the simulation. The simulated values of these variables of interest are compared for different proposed policy inputs to determine which set of outcomes is most desirable.

**Engineering, technology, and processes**

Simulation is an important feature in engineering systems or any system that involves many processes. For example, in [electrical engineering](https://en.wikipedia.org/wiki/Electrical_engineering), delay lines may be used to simulate [propagation delay](https://en.wikipedia.org/wiki/Propagation_delay) and [phase shift](https://en.wikipedia.org/wiki/Phase_%28waves%29#Phase_shift) caused by an actual [transmission line](https://en.wikipedia.org/wiki/Transmission_line). Similarly, [dummy loads](https://en.wikipedia.org/wiki/Dummy_load) may be used to simulate [impedance](https://en.wikipedia.org/wiki/Electrical_impedance) without simulating propagation and is used in situations where propagation is unwanted. A simulator may imitate only a few of the operations and functions of the unit it simulates. *Contrast with*: [emulate](https://en.wikipedia.org/wiki/Emulator).[[70]](https://en.wikipedia.org/wiki/Simulation#cite_note-FS1037C-70)

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](https://en.wikipedia.org/wiki/Fluid_dynamics) problems often require both mathematical and physical simulations. In these cases the physical models require [dynamic similitude](https://en.wikipedia.org/wiki/Similitude_%28model%29). Physical and chemical simulations have also direct realistic uses, rather than research uses; in [chemical engineering](https://en.wikipedia.org/wiki/Chemical_engineering), for example, [process simulations](https://en.wikipedia.org/wiki/Process_simulation) are used to give the process parameters immediately used for operating chemical plants, such as oil refineries. Simulators are also used for plant operator training. It is called Operator Training Simulator (OTS) and has been widely adopted by many industries from chemical to oil&gas and to the power industry. This created a safe and realistic virtual environment to train board operators and engineers. [Mimic](https://en.wikipedia.org/wiki/MiMiC_Simulation_Software) is capable of providing high fidelity dynamic models of nearly all chemical plants for operator training and control system testing.

**Finance**

In [finance](https://en.wikipedia.org/wiki/Finance), computer simulations are often used for scenario planning. [Risk](https://en.wikipedia.org/wiki/Risk)-adjusted [net present value](https://en.wikipedia.org/wiki/Net_present_value), for example, is computed from well-defined but not always known (or fixed) inputs. By imitating the performance of the project under evaluation, simulation can provide a distribution of NPV over a range of [discount rates](https://en.wikipedia.org/wiki/Discounts_and_allowances) and other variables. Simulations are also often used to test a financial theory or the ability of a financial model.[[79]](https://en.wikipedia.org/wiki/Simulation#cite_note-79)

Simulations are frequently used in financial training to engage participants in experiencing various historical as well as fictional situations. There are stock market simulations, portfolio simulations, risk management simulations or models and forex simulations. Such simulations are typically based on [stochastic asset models](https://en.wikipedia.org/wiki/Stochastic_asset_model). Using these simulations in a training program allows for the application of theory into a something akin to real life. As with other industries, the use of simulations can be technology or case-study driven.

Bearing resemblance to flight simulators, marine simulators train ships' personnel. The most common marine simulators include:

* Ship's bridge simulators
* Engine room simulators
* Cargo handling simulators
* Communication / [GMDSS](https://en.wikipedia.org/wiki/GMDSS) simulators
* ROV simulators

Simulators like these are mostly used within maritime colleges, training institutions, and navies. They often consist of a replication of a ships' bridge, with the operating console(s), and a number of screens on which the virtual surroundings are projected.

**Network and distributed systems**

Network and distributed systems have been extensively simulated in other to understand the impact of new protocols and algorithms before their deployment in the actual systems. The simulation can focus on different levels ([physical layer](https://en.wikipedia.org/wiki/Physical_layer), [network layer](https://en.wikipedia.org/wiki/Network_layer), [application layer](https://en.wikipedia.org/wiki/Application_layer)), and evaluate different metrics (network bandwidth, resource consumption, service time, dropped packets, system availability). Examples of simulation scenarios of network and distributed systems are:

* [Content delivery networks](https://en.wikipedia.org/wiki/Content_delivery_network)
* Smart cities
* Internet of things

**Payment and securities settlement system**

Simulation techniques have also been applied to payment and securities settlement systems. Among the main users are central banks who are generally responsible for the oversight of market infrastructure and entitled to contribute to the smooth functioning of the payment systems.

Central banks have been using payment system simulations to evaluate things such as the adequacy or sufficiency of liquidity available ( in the form of account balances and intraday credit limits) to participants (mainly banks) to allow efficient settlement of payments.[[85]](https://en.wikipedia.org/wiki/Simulation#cite_note-85)[[86]](https://en.wikipedia.org/wiki/Simulation#cite_note-86) The need for liquidity is also dependent on the availability and the type of netting procedures in the systems, thus some of the studies have a focus on system comparisons.[[87]](https://en.wikipedia.org/wiki/Simulation#cite_note-87)

Another application is to evaluate risks related to events such as communication network breakdowns or the inability of participants to send payments (e.g. in case of possible bank failure).[[88]](https://en.wikipedia.org/wiki/Simulation#cite_note-88) This kind of analysis falls under the concepts of [stress testing](https://en.wikipedia.org/wiki/Stress_testing) or [scenario analysis](https://en.wikipedia.org/wiki/Scenario_analysis).

A common way to conduct these simulations is to replicate the settlement logics of the real payment or securities settlement systems under analysis and then use real observed payment data. In case of system comparison or system development, naturally, also the other settlement logics need to be implemented.

To perform stress testing and scenario analysis, the observed data needs to be altered, e.g. some payments delayed or removed. To analyze the levels of liquidity, initial liquidity levels are varied. System comparisons (benchmarking) or evaluations of new netting algorithms or rules are performed by running simulations with a fixed set of data and varying only the system setups.

An inference is usually done by comparing the benchmark simulation results to the results of altered simulation setups by comparing indicators such as unsettled transactions or settlement delays.

**Project management**

Project management simulation is simulation used for project management training and analysis. It is often used as a 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.

**Robotics**

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](https://en.wikipedia.org/wiki/Physics_engine) to simulate a robot's dynamics.

**Production**

Simulation of [production systems](https://en.wikipedia.org/wiki/Operations_management#Production_systems) is used mainly to examine the effect of improvements or investments in a production system. Most often this is done using a static spreadsheet with process times and transportation times. For more sophisticated simulations [Discrete Event Simulation](https://en.wikipedia.org/wiki/Discrete_Event_Simulation) (DES) is used with the advantages to simulate dynamics in the production system. A production system is very much dynamic depending on variations in manufacturing processes, assembly times, machine set-ups, breaks, breakdowns and small stoppages.[[89]](https://en.wikipedia.org/wiki/Simulation#cite_note-89) There is much [software](https://en.wikipedia.org/wiki/List_of_discrete_event_simulation_software) commonly used for discrete event simulation. They differ in usability and markets but do often share the same foundation.

**Sales process**

Simulations are useful in modeling the flow of transactions through business processes, such as in the field of [sales process engineering](https://en.wikipedia.org/wiki/Sales_process_engineering), to study and improve the flow of customer orders through various stages of completion (say, from an initial proposal for providing goods/services through order acceptance and installation). Such simulations can help predict the impact of how improvements in methods might impact variability, cost, labor time, and the number of transactions at various stages in the process. A full-featured computerized process simulator can be used to depict such models, as can simpler educational demonstrations using spreadsheet software, pennies being transferred between cups based on the roll of a die, or dipping into a tub of colored beads with a scoop.

**Sports**

In sports, [computer simulations](https://en.wikipedia.org/wiki/Computer_simulation) are often done to predict the outcome of events and the performance of individual sportspeople. They attempt to recreate the event through models built from [statistics](https://en.wikipedia.org/wiki/Statistics). The increase in technology has allowed anyone with knowledge of programming the ability to run simulations of their models. The simulations are built from a series of mathematical [algorithms](https://en.wikipedia.org/wiki/Algorithms), or models, and can vary with accuracy. Accuscore, which is licensed by companies such as [ESPN](https://en.wikipedia.org/wiki/ESPN), is a well-known simulation program for all major [sports](https://en.wikipedia.org/wiki/Sports). It offers a detailed analysis of games through simulated betting lines, projected point totals and overall probabilities.

With the increased interest in [fantasy sports](https://en.wikipedia.org/wiki/Fantasy_sports) simulation models that predict individual player performance have gained popularity. Companies like What If Sports and StatFox specialize in not only using their simulations for predicting game results but how well individual players will do as well. Many people use models to determine whom to start in their fantasy leagues.

Another way simulations are helping the sports field is in the use of [biomechanics](https://en.wikipedia.org/wiki/Biomechanics). Models are derived and simulations are run from data received from sensors attached to athletes and video equipment. [Sports biomechanics](https://en.wikipedia.org/wiki/Sports_biomechanics) aided by simulation models answer questions regarding training techniques such as the effect of fatigue on throwing performance (height of throw) and biomechanical factors of the upper limbs (reactive strength index; hand contact time).[[91]](https://en.wikipedia.org/wiki/Simulation#cite_note-91)

Computer simulations allow their users to take models which before were too complex to run, and give them answers. Simulations have proven to be some of the best insights into both play performance and team predictability.

**Space shuttle countdown**

Simulation was used at [Kennedy Space Center](https://en.wikipedia.org/wiki/Kennedy_Space_Center) (KSC) to train and certify [Space Shuttle](https://en.wikipedia.org/wiki/Space_Shuttle) engineers during simulated launch countdown operations. The Space Shuttle engineering community would participate in a launch countdown integrated simulation before each Shuttle flight. This simulation is a virtual simulation where real people interact with simulated Space Shuttle vehicle and Ground Support Equipment (GSE) hardware. The Shuttle Final Countdown Phase Simulation, also known as S0044, involved countdown processes that would integrate many of the Space Shuttle vehicle and GSE systems. Some of the Shuttle systems integrated in the simulation are the main propulsion system, [RS-25](https://en.wikipedia.org/wiki/RS-25), [solid rocket boosters](https://en.wikipedia.org/wiki/Space_Shuttle_Solid_Rocket_Booster), ground liquid hydrogen and liquid oxygen, [external tank](https://en.wikipedia.org/wiki/External_tank), flight controls, navigation, and avionics.[[92]](https://en.wikipedia.org/wiki/Simulation#cite_note-92) The high-level objectives of the Shuttle Final Countdown Phase Simulation are:

* To demonstrate [Firing Room](https://en.wikipedia.org/wiki/Firing_room#Firing_room) final countdown phase operations.
* To provide training for system engineers in recognizing, reporting and evaluating system problems in a time critical environment.
* To exercise the launch team's ability to evaluate, prioritize and respond to problems in an integrated manner within a time critical environment.
* To provide procedures to be used in performing failure/recovery testing of the operations performed in the final countdown phase.[[93]](https://en.wikipedia.org/wiki/Simulation#cite_note-93)

The Shuttle Final Countdown Phase Simulation took place at the [Kennedy Space Center](https://en.wikipedia.org/wiki/Kennedy_Space_Center) [Launch Control Center](https://en.wikipedia.org/wiki/Launch_Control_Center) [Firing Rooms](https://en.wikipedia.org/wiki/Firing_room#Firing_room). The firing room used during the simulation is the same control room where real launch countdown operations are executed. As a result, equipment used for real launch countdown operations is engaged. Command and control computers, application software, engineering plotting and trending tools, launch countdown procedure documents, launch commit criteria documents, hardware requirement documents, and any other items used by the engineering launch countdown teams during real launch countdown operations are used during the simulation. The Space Shuttle vehicle hardware and related GSE hardware is simulated by [mathematical models](https://en.wikipedia.org/wiki/Mathematical_models) (written in Shuttle Ground Operations Simulator (SGOS) modeling language[[94]](https://en.wikipedia.org/wiki/Simulation%22%20%5Cl%20%22cite_note-94)) that behave and react like real hardware. During the Shuttle Final Countdown Phase Simulation, engineers command and control hardware via real application software executing in the control consoles – just as if they were commanding real vehicle hardware. However, these real software applications do not interface with real Shuttle hardware during simulations. Instead, the applications interface with mathematical model representations of the vehicle and GSE hardware. Consequently, the simulations bypass sensitive and even dangerous mechanisms while providing engineering measurements detailing how the hardware would have reacted. Since these math models interact with the command and control application software, models and simulations are also used to debug and verify the functionality of application software.[[95]](https://en.wikipedia.org/wiki/Simulation#cite_note-95)

**Satellite navigation**

The only true way to test [GNSS](https://en.wikipedia.org/wiki/GNSS) receivers (commonly known as Sat-Nav's in the commercial world) is by using an RF Constellation Simulator. A receiver that may, for example, be used on an aircraft, can be tested under dynamic conditions without the need to take it on a real flight. The test conditions can be repeated exactly, and there is full control over all the test parameters. this is not possible in the 'real-world' using the actual signals. For testing receivers that will use the new [Galileo (satellite navigation)](https://en.wikipedia.org/wiki/Galileo_%28satellite_navigation%29) there is no alternative, as the real signals do not yet exist.

**Weather**

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 helps in predicting and forewarning about extreme weather conditions like the path of an active hurricane/cyclone. [Numerical weather prediction](https://en.wikipedia.org/wiki/Numerical_weather_prediction) for forecasting involves complicated numeric computer models to predict weather accurately by taking many parameters into account.