**Simulation**

A **simulation** is an approximate [imitation](https://en.wikipedia.org/wiki/Imitation) of the operation of a process or system; that represents its operation over time.

Simulation is used in many contexts, such as simulation of [technology](https://en.wikipedia.org/wiki/Technology) for [performance tuning](https://en.wikipedia.org/wiki/Performance_tuning) or optimizing, [safety engineering](https://en.wikipedia.org/wiki/Safety_engineering), [testing](https://en.wikipedia.org/wiki/Experiment), [training](https://en.wikipedia.org/wiki/Training), [education](https://en.wikipedia.org/wiki/Education), and [video games](https://en.wikipedia.org/wiki/Video_game). Often, [computer experiments](https://en.wikipedia.org/wiki/Computer_experiment) are used to study simulation models. Simulation is also used with [scientific modelling](https://en.wikipedia.org/wiki/Scientific_modelling) of natural systems or human systems to gain insight into their functioning, as in [economics](https://en.wikipedia.org/wiki/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.

Key issues in simulation include the acquisition of valid sources of 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](https://en.wikipedia.org/wiki/Verification_and_validation_of_computer_simulation_models) are an ongoing field of academic study, refinement, research and development in simulations technology or practice, particularly in the work of [computer simulation](https://en.wikipedia.org/wiki/Computer_simulation).

## Classification and terminology

Historically, simulations used in different fields developed largely independently, but 20th-century studies of [systems theory](https://en.wikipedia.org/wiki/Systems_theory) and [cybernetics](https://en.wikipedia.org/wiki/Cybernetics) combined with spreading use of computers across all those fields have led to some unification and a more systematic view of the concept.

***Physical simulation*** refers to simulation in which physical objects are substituted for the real thing (some circlesuse the term for computer simulations modelling selected laws of [physics](https://en.wikipedia.org/wiki/Physics), but this article does not). These physical objects are often chosen because they are smaller or cheaper than the actual object or system.

***Interactive simulation*** is a special kind of physical simulation, often referred to as a [*human in the loop*](https://en.wikipedia.org/wiki/Human-in-the-loop) simulation, in which physical simulations include human operators, such as in a [flight simulator](https://en.wikipedia.org/wiki/Flight_simulator), [sailing simulator](https://en.wikipedia.org/wiki/Maritime_simulator), or [driving simulator](https://en.wikipedia.org/wiki/Driving_simulator).

[***Continuous simulation***](https://en.wikipedia.org/wiki/Continuous_simulation) is a simulation based on continuous time, rather than discrete time steps, using numerical integration of [differential equations](https://en.wikipedia.org/wiki/Differential_equation).

[***Discrete-event simulation***](https://en.wikipedia.org/wiki/Discrete-event_simulation) studies systems whose states change their values only at discrete times.[[6]](https://en.wikipedia.org/wiki/Simulation#cite_note-6) For example, a simulation of an epidemic could change the number of infected people at time instants when susceptible individuals get infected or when infected individuals recover.

[***Stochastic simulation***](https://en.wikipedia.org/wiki/Stochastic_simulation)is a simulation where some variable or process is subject to random variations and is projected using [Monte Carlo](https://en.wikipedia.org/wiki/Monte_Carlo_method) techniques using pseudo-random numbers. Thus replicated runs with the same boundary conditions will each produce different results within a specific confidence band.

[***Deterministic simulation***](https://en.wikipedia.org/wiki/Deterministic_simulation)is a simulation which is not stochastic: thus the variables are regulated by deterministic algorithms. So replicated runs from the same boundary conditions always produce identical results.

***Hybrid Simulation*** (sometime Combined Simulation) corresponds to a mix between Continuous and Discrete Event Simulation and results in integrating numerically the differential equations between two sequential events to reduce the number of discontinuities.

A ***stand alone simulation*** is a simulation running on a single workstation by itself.

A ***distributed simulation*** is one which uses more than one computer simultaneously, in order to guarantee access from/to different resources (e.g. multi-users operating different systems, or distributed data sets); a classical example is [Distributed Interactive Simulation](https://en.wikipedia.org/wiki/Distributed_Interactive_Simulation) (DIS).

***Parallel Simulation*** speeds up a simulation's execution by concurrently distributing its workload over multiple processors, as in [High-Performance Computing](https://en.wikipedia.org/wiki/High-Performance_Computing).

***Interoperable Simulation*** where multiple models, simulators (often defined as Federates) interoperate locally, distributed over a network; a classical example is [High-Level Architecture](https://en.wikipedia.org/wiki/High-Level_Architecture).

***Modeling & Simulation as a Service*** where simulation is accessed as a service over the web.

***Modeling, interoperable Simulation and Serious Games*** where Serious Games Approaches (e.g. Game Engines and Engagement Methods) are integrated with Interoperable Simulation.

***Simulation Fidelity*** is used to describe the accuracy of a simulation and how closely it imitates the real-life counterpart. Fidelity is broadly classified as one of three categories: low, medium, and high. Specific descriptions of fidelity levels are subject to interpretation, but the following generalizations can be made:

* Low – the minimum simulation required for a system to respond to accept inputs and provide outputs
* Medium – responds automatically to stimuli, with limited accuracy
* High – nearly indistinguishable or as close as possible to the real system

Human in the loop simulations can include a computer simulation as a so-called ***synthetic environment*.**

***Simulation in failure analysis*** refers to simulation in which we create environment/conditions to identify the cause of equipment failure. This was the best and fastest method to identify the failure cause.