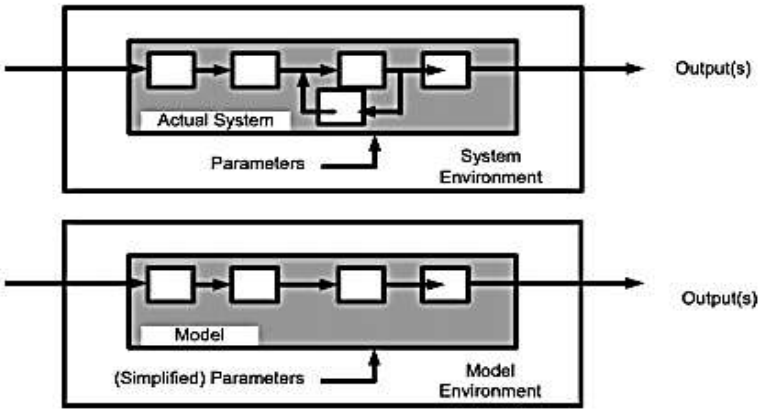
What is a model ?

Simulations require the use of models; the model represents the key characteristics or behaviors of the selected system or process, whereas the simulation represents the evolution of the model over time.



Model

A model is a physical, mathematical, or logical representation of a system entity, phenomenon, or process.

The **model** is a functional description of the system's components and their interaction

Objects of the model

There are two types of objects a simulation model is often made of:

Entities: individual elements of the system that are being simulated and whose behavior is being explicitly tracked. Each entity can be individually identified;

Resources: also individual elements of the system but they are not modelled individually. They are treated as countable items whose behavior is not tracked.

Type of models

Physical model (scale models, prototype plants, …)

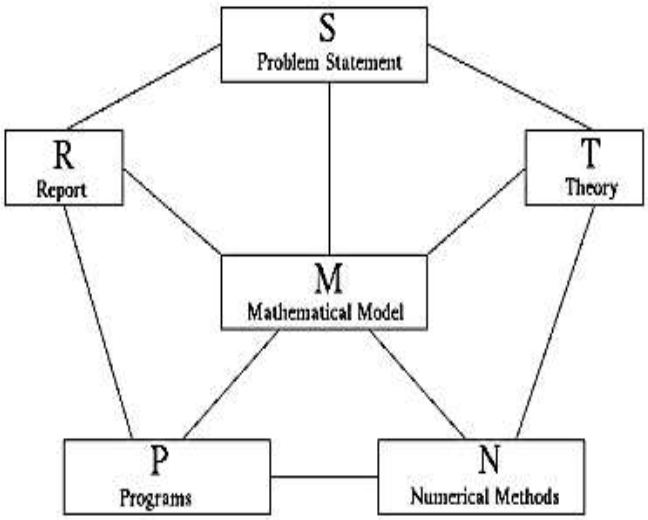
Sometimes small scale physical models are used to evaluate constructions, e.g. air plane or car models in wind tunnels, ship models in swimming pools etc.

Mathematical model (Analytical queueing models, linear programs, simulation)

The vast majority of used models are mathematical, representing a system in terms of logical and quantitative relationships that are possible to manipulate and change to see how the model reacts.

Mathematical model

Mathematical models are used in the natural sciences (such as physics, biology, earth science, chemistry) and engineering disciplines (such as computer science, electrical engineering), as well as in non-physical systems such as the social sciences (such as economics, sociology).



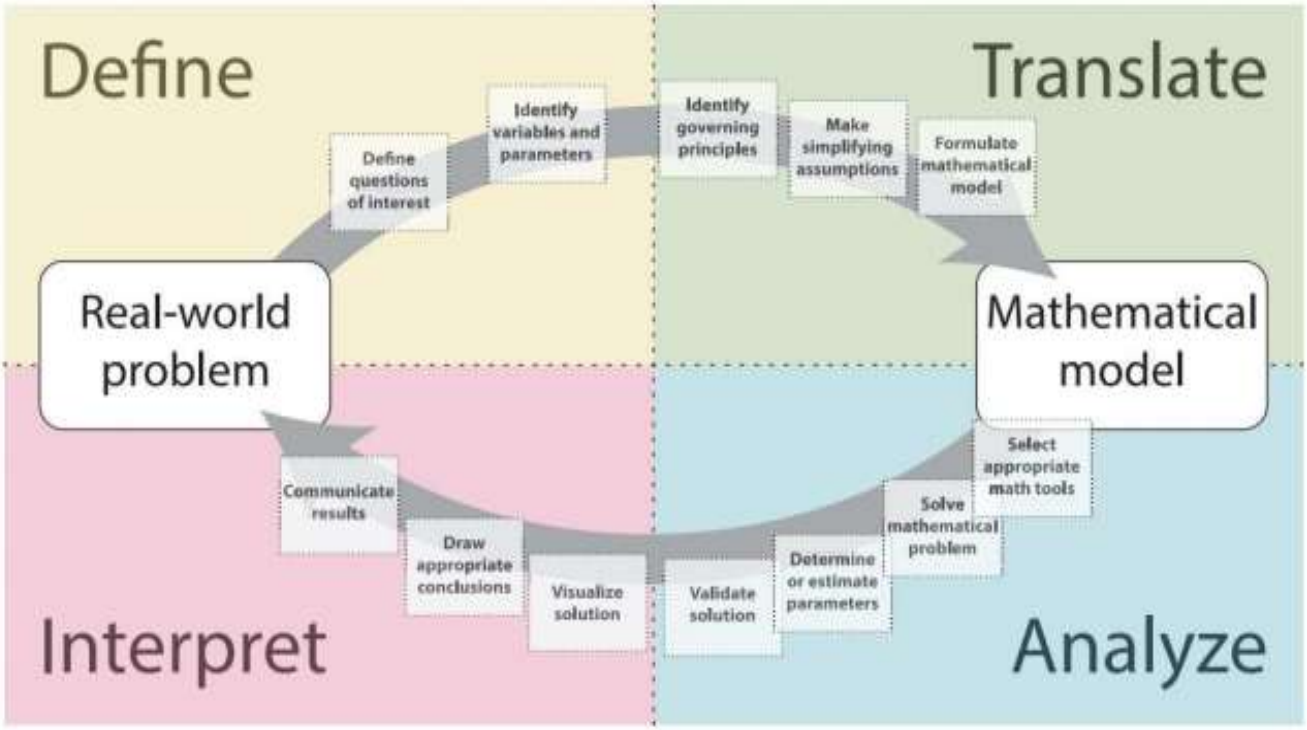
Mathematical model

Also defined a mathematical model as

'a representation of the essential aspects of an existing system (or a system to be constructed) which presents knowledge of that system in usable form'.

A mathematical model is a description of a system using mathematical concepts and language.

Schematic representation of the mathematical modeling process



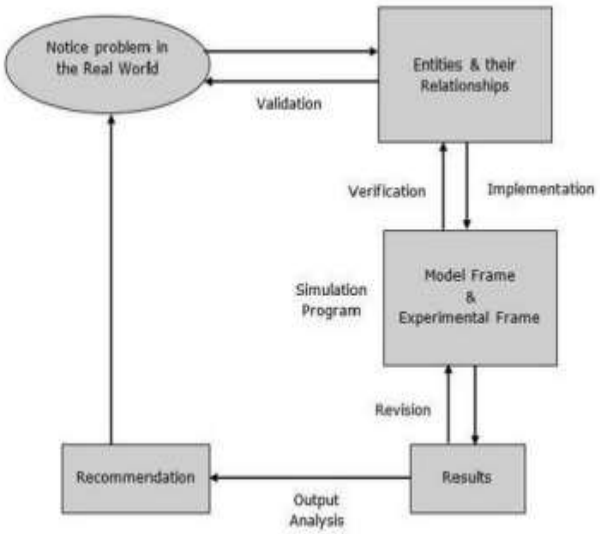
Modelling

Modelling is the process of representing a model which includes its construction and working.

This model is similar to a real system, which helps the analyst predict the effect of changes to the system.

In other words, modelling is creating a model which represents a system including their properties. It is an act of building a model.

Modelling Process



Step 1 – Examine the problem. In this stage, we must understand the problem and choose its classification accordingly, such as deterministic or stochastic.

Step 2 – Design a model. In this stage, we have to perform the following simple tasks which help us design a model.

Step 3 – Provide recommendations after completing the entire process related to the model. It includes investment, resources, algorithms, techniques, etc.

Modeling approaches

Empirical modeling involves examining data related to the problem with a view of formulating or constructing a mathematical relationship between the variables in the problem using the available data.

Simulation modeling involve the use of a computer program or some technological tool to generate a scenario based on a set of rules. These rules arise from an interpretation of how a certain process is supposed to evolve or progress.

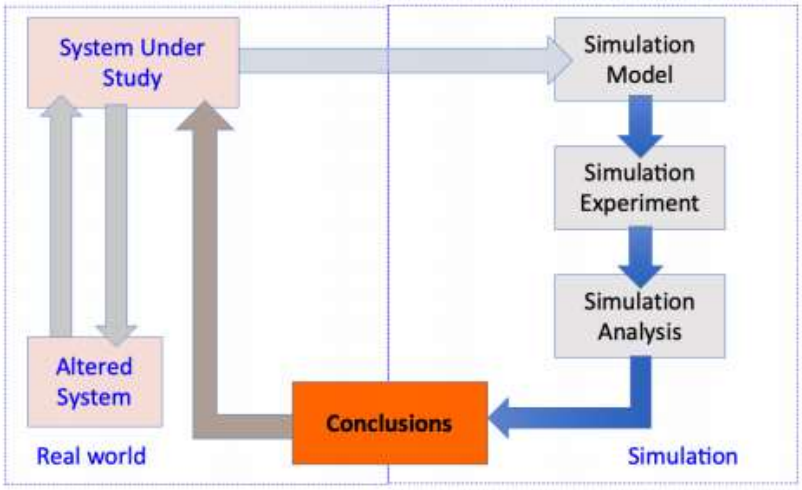
Deterministic modeling in general involve the use of equation or set of equations to model or predict the outcome of an event or the value of a quantity.

Stochastic modeling takes deterministic modeling one further step. In stochastic models, randomness and probabilities of events happening are taken into account when the equations are formulated.

What is Simulation ?

A simulation is the imitation of the operation of a real-world process or system over time.

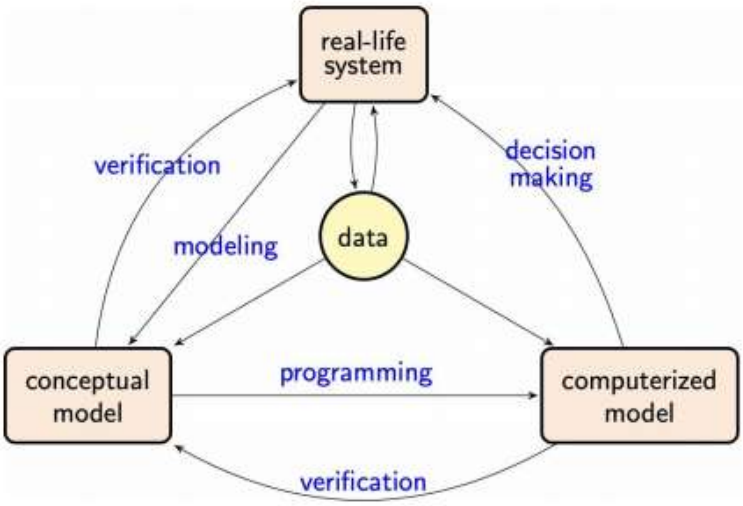
A simulation is an animated model that mimics the operation of an existing or proposed system.



Simulation

A simulation is a computer model in which experiments can be conducted, creating a higher level of completeness than a normal experiment.

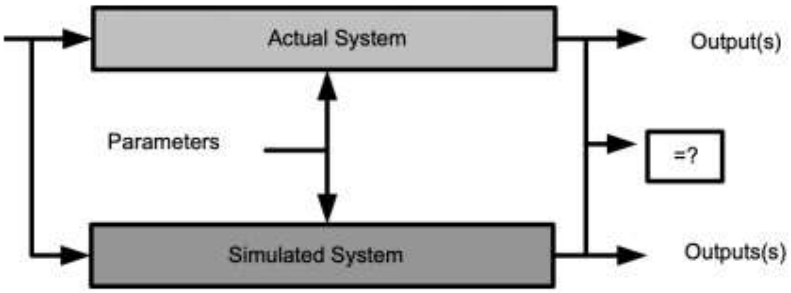
Simulation models can assist in both complex and simple experiments, and they can be used with almost any social process.



Simulation

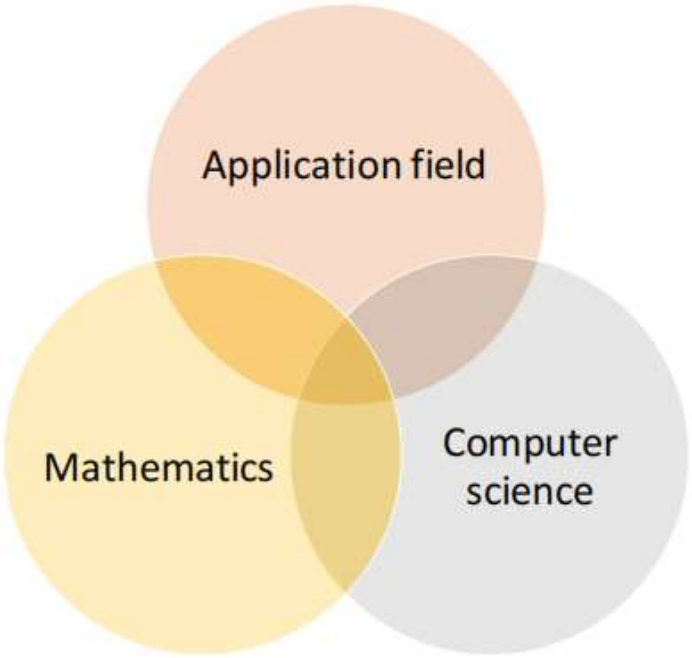
Simulation of a system is the operation of a model in terms of time or space, which helps analyze the performance of an existing or a proposed system.

In other words, simulation is the process of using a model to study the performance of a system. It is an act of using a model for simulation.



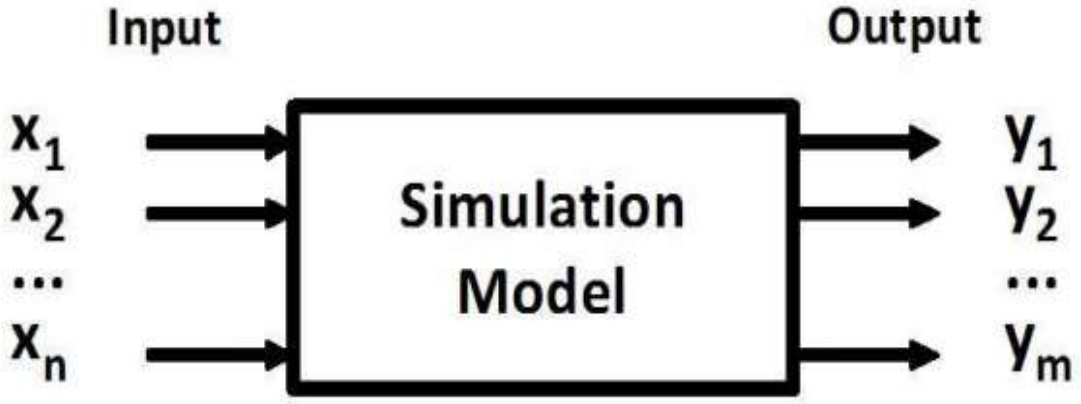
Definition

Simulation can be broadly defined as a technique for studying real-world dynamical systems by imitating their behavior using a mathematical model of the system implemented on a digital computer.



Simulation modeling

Simulation modeling is used to help designers and engineers understand whether, under what conditions, and in which ways a part could fail and what loads it can withstand.



Seteps for Developing Simulation Models

Step 1 : Identify the problem with an existing system or set requirements of a proposed system.

Step 2 : Design the problem while taking care of the existing system factors and limitations.

Step 3 : Collect and start processing the system data, observing its performance and result.

Step 4 : Develop the model using network diagrams and verify it using various verifications techniques.

Step 5 : Validate the model by comparing its performance under various conditions with the real system.

Step 6 : Create a document of the model for future use, which includes objectives, assumptions, input variables and performance in detail.

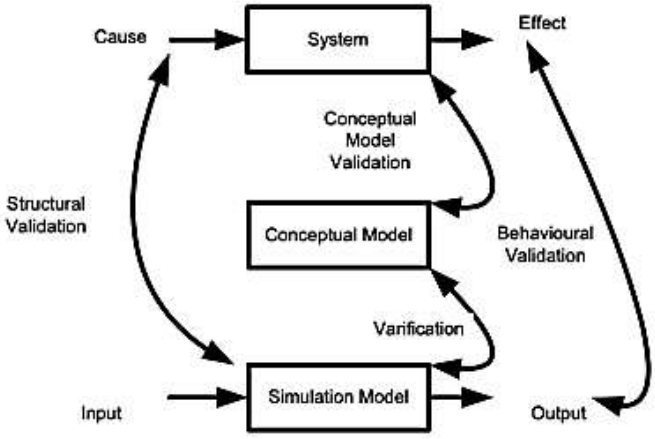
Step 7 : Select an appropriate experimental design as per requirement.

Step 8 : Induce experimental conditions on the model and observe the result.

Verification & Validation

Validation is the process of comparing two results. In this process, we need to compare the representation of a conceptual model to the real system. If the comparison is true, then it is valid, else invalid.

Verification is the process of comparing two or more results to ensure its accuracy. In this process, we have to compare the model's implementation and its associated data with the developer's conceptual description and specifications.



Classes of Simulations

The three classes of models and simulations are

- **Virtual simulations** represent systems both physically and electronically.
- **Constructive simulations** represent a system and its employment.
- **Live simulations** are simulated operations with real operators and real equipment