



Introduction to Simulation



What is simulation?

- To mimic a real world process or system over time
- The imitation of some real thing, state of affairs or processes.
- A description of some system to intend to predict what happen if certain actions are taken.



Aims and uses

What are the aims of simulation?

- To provide a platform on which systems (either real or proposed) may be re-created for the purposes of:
 - ✓ Training
 - ✓ Visualisation
 - ✓ Research
 - ✓ Analysing
 - ✓ Optimisation
- A “*What if?*” Tool.



Uses

Why is simulation used?

- The availability of today’s computing capabilities and advances in simulation methodologies have made simulation one of the most widely used tools in operations research and system analysis.
- For instance simulation is used before an existing system is altered or a new system is built to:
 - Reduce the chances of failure to meet specifications.
 - To eliminate unforeseen bottlenecks.
 - To prevent under or over-utilisation of resources.
 - To optimise system performance.



Uses

- Simulation can be used to answer questions like:
 - What is the best design for a new telecoms network?
 - What are the associated resource requirements?
 - How will the telecoms network perform when the traffic doubles?
 - How will a new routing algorithm affect its performance?
 - Which network protocol optimises network performance?
 - What will be the impact of a link failure?
- In simulation time can be compressed or expanded for speed up or slow down of the system under investigation.



Abilities

Simulation is able to:

- Compress/expand time
- Speed up/slow down
- Control sources of variation
- Stop and review
- Restore system state
- Replicate systems
- Control level of detail



Areas of application

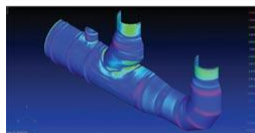
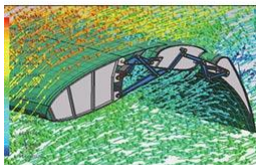
- Manufacturing systems
- Healthcare
- Military
- Natural Resources
- Transportation systems
- Construction systems
- Restaurant and entertainment systems
- Computer system performance
- Teaching
- Gaming
- ...and more.



Classification

Classification of simulation techniques

- Simulation can be (broadly) classified into two:
 1. Analogue
 2. Digital





Classification

Analogue simulation

- Analogue simulations are either scale models or analogues with the elements having one to one correspondence with the system being simulated.
- Examples:
 - ✓ Car accident simulations
 - ✓ Wind tunnels
 - ✓ A flight simulator which can simulate the conditions in an aircraft cockpit.



Classification

An airbus A380 flight simulator





Classification

Digital simulation

- Simulation of systems in a digital form on a digital computer.
- Varies from computer programs that run for a few minutes, to network based groups of computers running for hours to ongoing simulation that run for days.
- There are two approaches for creating digital simulations:
 1. Using a conventional program-oriented approach
 2. Using a software package-oriented approach.



Classification

Digital simulation using the program-oriented approach

- In the program-oriented approach, the systems to be modelled are modelled using a high level language such as Java, C#, C and FORTRAN.
- To use this approach, very good programming skills are required.
- The success of the simulation depends on the ability of the programmer that develops the software.



Classification

Digital simulation using the package-oriented approach

- In this approach, a simulation package is used to develop the simulation.
- The proper choice of the package is essential as each one is tailor-made for a class of problems.
- There are two types of simulation packages:
 1. Simulation languages
 2. Application-oriented simulators



Classification

The package-oriented approach using simulation languages

- Simulation languages are high-level programming languages with added features/capabilities that are required for simulation.
- Examples of the added features includes:
 - Visualisation capabilities
 - Advanced random number generators
 - Support for statistical data
- To use such languages programming expertise is required.



Classification

List of some simulation languages

- GPSS (<http://www.webgpss.com/>)
- MODSIM (<http://www.modsim.org/>)
- Simula



Classification

The package-oriented approach using applications

- Use of software packages does not require any programming skill.
- Each software is limited in its application, therefore its scope is restrictive.
- Less flexibility as there is no scope for generalisation as in programming.



Classification

List of some application-oriented packages

- Arena (<http://www.arenasimulation.com/>)
- MATLAB (<http://www.mathworks.co.uk/>)
- PSpice (<http://www.electronics-lab.com/>)
- Orcad (<http://www.cadence.com/orcad/>)
- Mathematica (<http://www.wolfram.com/>)
- LabVIEW (<http://www.ni.com/labview/>)
- AutoCAD (<http://www.autodesk.co.uk/>)
- Proteus (<http://www.labcenter.co.uk/>)



Bibliography

Papers

Anu, M. (1997). Introduction to modelling and simulation. *Proceedings of the 1997 Winter Simulation Conference*, (pp. 7-13).

K, Mohandas. P. Introduction to simulaiton.

Ricki, I. G. (2002). Introduction to Simulation. *Proceedigs of the 2002 Winter Sumulaiton Conference*, (pp. 7-16).