Computer Modelling and Simulation as a Learning Tool
A Preliminary Study of Network Simulation Products

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ABSTRACT

Today, computer simulation plays a significant role in the process of decision-making and planning. Furthermore, it can act as an effective tool for learning, teaching and training.

Educating and training learners in the field of communications and Web enabling technologies can be a costly exercise – as theory often needs to be supported by hands-on practice in workshops or labs. In this case, computer simulation products can often prove to be an alternative cost-effective solution.

This paper introduces a methodology for evaluating such products and discusses the results of a preliminary study of a number of options that are currently available within the marketplace.

1. INTRODUCTION

'Simulation' refers to a simplified representation of an original case. That is to say, a simulation model captures key functional features and attributes of a real life system – such as building a model vehicle that captures a large number of the important physical characteristics and features of a real car in order to conduct certain tests. A computer simulation software is a program that is developed in order to mimic the entities and the functions of a real life system.

During the past few years, computer simulation has provided organisations with the means by which to establish a quicker understanding of how to prepare in order to respond to change. The Information Technology (IT) industry and the educational sector can both benefit from the application of computer simulation. Where the former is concerned, network simulation is an indispensable tool for network design, testing and capacity planning.

With regards to teaching and training, computer simulation and modelling can act as an effective support tool - in particular within the areas of data communications and Web enabling technologies whereby theory needs to be supported by hands-on practice in workshops or labs. Networking simulation products can therefore prove to be an alternative cost-effective solution.

In early 2001, I initiated a research programme in order to firstly, establish interest groups and secondly, to motivate research in the application of computer simulation within various industries. Phase I of the programme focused primarily on the application of simulation in computer networking. It involved a research project that investigated various network simulation products that are currently available within
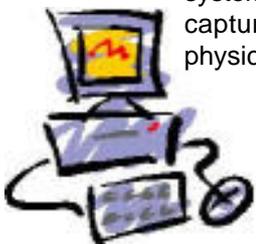
the market place – with a focus on investigating the feasibility of using computer simulation for some aspects of teaching or learning as a potential substitute for physical networking labs and workshops.

In this paper, the application of computer simulation is discussed. This is followed by outlining the preliminary results of a product evaluation – whereby key product features such as supporting platforms, functionality and price range are addressed. Furthermore, recommendations have been made in regards to the ways in which these products may be applied in supporting the learning process.

2. THE APPLICATION OF COMPUTER SIMULATION

The application of computer simulation can potentially improve the quality and effectiveness of the decision making process. In general, modelling and simulation can be considered as a decision support tool. It provides us with a more economical and safer option in order to learn from potential mistakes - that is to say, it can reduce cost, risk, and improve our understanding of the real life systems that are being investigated.

Computer simulation translates some aspects of the physical world into a mathematical model (description) followed by regenerating that model on a computer – which can be used instead of performing an actual physical task. For instance, simulations of flying an airplane provide an excellent tool for flight training.

A quick review of some of the projects that are currently employing computer modelling reveals various applications such as:

♦ Training people to perform complex tasks
♦ Designing better computer chips
♦ Providing better weather forecasts
♦ Performing predictions of the global economy
♦ Studying social interaction
♦ Analyzing financial risks
♦ Compiling complex corporate plans
♦ Designing complex computer networks.

In summary, computer simulation can be applied in order to:

1. Improve communication – e.g. standardizing the treatment of experimental data and the description of results to various interest groups within an organization
2. Build a knowledge base of quantitative information
3. Characterize the data mathematically, by parameter fitting - rather than continually referring to the raw data
4. Validate a process – to increase understanding of the process
5. Study reproducibility - to determine those factors to which the process is sensitive and quantify their effect
6. Study process economics - to perform cost/benefit analyses for different operational scenarios
7. Reduce laboratory costs - to reduce trial-and-error experimentation over the long term (Please note that there maybe an initial increase in experimentation to obtain the data to build the simulation models)
8. Study process optimization – to perform 'what-if' scenarios and investigate different possibilities.

3. THE PRODUCT EVALUATION PROCESS

3.1 METHODOLOGY

The methodology (framework) that was applied in order to evaluate product options is as follows:

1. Establishing the general evaluation criteria
2. Preliminary research of products
3. Producing a short list of products from the previous step (level 1 search) for a more detailed analysis in order to identify potential candidates
4. Establishing a focus group for reviewing products
5. Where appropriate, establishing a more detailed evaluation criteria and a rating scheme
6. Reviewing of the list of the potential candidates in order to recommend a suitable product (or a portfolio of products).

3.2 PRODUCT EVALUATION CRITERIA

Based on a review of literature and discussions within a small focus group, the following general criteria were agreed upon.

Main Features:

♦ Application of the product (with a focus on modelling computer networks)
♦ Import/Export facilities

- ◆ Flexibility
- ◆ Online help
- ◆ Functionality (Capabilities) – suitable for learners
- ◆ User interface features
- ◆ Compatibility with our existing platform(s)
- ◆ Ease of use.
  Other Criteria:
- ◆ Costs
- ◆ IMS Compliance
- ◆ Training needs
- ◆ Upgrades
- ◆ Vendor partnership.

3.3 THE SEARCH FOR POTENTIAL APPLICATIONS

The search for computer simulation and modelling applications that are currently available was carried out in two phases. The sources of information that were taken into consideration included:

- ◆ The internet (the main source of information)
- ◆ Application developers/suppliers
- ◆ Potential user communities.

The preliminary search produced a list of more than 50 products. In brief:

- ◆ Most of these products support various Window platforms (95/98/2000/NT)
- ◆ They are designed to model various applications (business decision making, network design and evaluation and various specialised industrial applications)
- ◆ The price (licensing fees) range from a few hundred US dollars (USD) to over USD100,000
- ◆ They offer a wide range of functions including graphical modelling tools, graphical user interface, probability distribution function matching and so on.

Next (following a more vigorous application of the criteria that was agreed upon in Section 3.2), these products were further evaluated in order to prepare a short list of potential applications for a detailed analysis. The shortlist included 17 applications as follows:

- ◆ @Risk
- ◆ Advanced Continuous Simulation Language (ACSL Sim Suite)

- ◆ Alpha/Sim
- ◆ AweSim
- ◆ Clarinet
- ◆ ExpertFit
- ◆ GPSS/H
- ◆ IGrafix Process
- ◆ Micro Saint
- ◆ PASION
- ◆ SDI Industry, SDI Industry Pro, SDI Industry Chain
- ◆ SimLogic
- ◆ SIMPROCESS
- ◆ SIMSCRIPT
- ◆ SimSheet
- ◆ Simul8 Professional
- ◆ Taylor II Simulation Software.

Note: COMNET III was removed from the list as we learned that the product is discontinued.

A summary of the findings of a more detailed study of the key features of these products (e.g. platforms, licensing fees, and a summary of key features) is outlined in Appendix A.

4. THE OUTCOME

Having considered the objectives of this project, its scope and size, and the allocated funding, it was decided that at is point time a detailed rating of potential product options would not be carried out.

Based on the analysis of the short-listed products (and considering the scope and objectives of the project), it appears that there are significant benefits in:

- ◆ Considering a portfolio of products that support various functions at entry level
- ◆ Avoiding high-price options at early stages of implementing our plan
- ◆ Considering a trial period during which students and staff are introduced to a selected portfolio of easy to learn and use products
- ◆ Considering products that are available to be examined during a trial period
- ◆ Aligning the process of product selection and implementation with real projects that would utilise these products in order to achieve agreed upon outcomes.

I would therefore like to recommend that the suitable computer simulation products be introduced in two phases:

♦ Phase I – in the sort-term, consider 'ExpertFit' and a portfolio of products such as '@Risk' 'Pasion', 'ShowFlow', or 'AweSim'

♦ Phase II – in the long term consider products such as 'SIMSCRIPT', 'SIMUL8' or a product similar to 'COMNET III.' Please note that 'SIMPROCESS' or a similar product can also prove beneficial – for simulation of business processes.

5. CONCLUSIONS

The key objectives of this study were:

♦ Clarifying the applications of computer simulation

♦ Verifying the key criteria with regards to the evaluation of simulation packages (with a focus on computer networking and communication technologies)

♦ Identifying a portfolio of products that can support the objectives of this project.

In general, computer simulation plays a significant role in the decision making process – it has provided organisations with the means by which to establish a quicker understanding of how to prepare and how to respond to change. It is also an effective tool that can facilitate teaching, training and learning. Today, the Information Technology (IT) industry and the educational sector both benefit from the application of computer simulation.

A wide range of computer simulation packages is currently available. Most products support various Window platforms (95/98/2000/NT) and provide varying degrees of functionality.

This study initially considered over 50 applications; this was later reduced to a shortlist of 17 products.

Following the analysis of the requirements and the study of the short-listed products, it is recommended that a step-by-step implementation process be considered. More specifically, it was recommended

♦ In the sort-term (Phase I), consider a portfolio of entry-level products on a trial basis (such as 'ExpertFit', 'Pasion', '@Risk', 'ShowFlow', 'AweSim')

♦ In the long-term (Phase II), introduce products that offer more sophisticated features (such as 'SIMSCRIPT', 'SIMUL8' or 'SIMPROCESS').

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Appendix A – A Summary of Product Features

Product	Platform	Price	Comments in regards with features and functionality
1 @Risk	Win95/98/2000/NT	NZD1638 to NZD3792 (Standard, Professional and Industrial editions)	- HRS LTD markets the product locally in NZ - It is a simulation and risk analysis add-in for MS Excel to perform Monte Carlo simulation - Limited information was made available with regards to features and functionality
2 Advanced Continuous Simulation Language (ACSL Sim Suite)	Windows	TBA	- This product is a package that contains ACSL Graphic Modeller, ACSL Sim and ACSL Math - Graphical modeller is a full-featured visual programming tool using the so-called "PowerBlocks" - ACSL Sim combines ACSL language and a full set of ACSL runtime libraries - It is more suitable for the simulation of industrial cases and problems
3 AlphaSim	Win NT, UNIX	USD1,995 - USD3,995 per license	- It is a general purpose discrete even simulation software - The products supports graphical interface
4 AweSim	Windows	From USD500 to USD14,500 (USD1000 for academic license)	- This is a discrete event simulation as well as continuous simulation tool for various applications - It produces model animations for graphical interactive simulation
5 Clarinet	Win95/98/NT	TBA	- The product is designed to analyse ATM, WAN and LAN networks - It can be used for signalling and protocol conformance testing - It covers a wide range of protocols (ATM, Frame Relay, LAN/Ethernet, IP, ISDN, QSIG, X.25 and many others) - The product provides a unique Automatic Simulator feature (a few click can help simulating network devices and generating traffic
6 ExpertFit	PC	USD395 to USD995 (Academic discounts available)	- It identifies best probability distribution fit for a data set - It supports most other simulation packages that have been discussed in this chart
7 GPSS/H	PC, Sparc	USD2,500 - USD5,200 (GPSS/H Personal USD1500)	- This is a general purpose discrete even simulation software - It is capable of providing graphical interface
8 IGrafix Process	Win95/98/2000/NT	NZD1360 – for academic edition	- This is a tool for process improvement - It provides graphical tools and tools for producing diagrams - It can analyse "what-if" scenarios - It is compatible with Microsoft Office, VB and OLE - In NZ it is marketed by various firms – in Christchurch three firms market and supply the product.
9 Micro Saint	Win95/98/NT	USD8,995	- This is a general purpose discrete even simulation software - It can support graphical interface - It uses flowcharting for modelling - The product offers a built in optimisation and animation tool

Product	Platform	Price	Comments in regards with features and functionality
10 PASION	Windows	USD90 (download)	This is an object oriented Pascal-based simulation language • It build a simulation model based on processes and events (build process instances and activates them) • It can be used for both discrete-event and continuous simulation • It is compatible (can be compiled) with Delphi 3, 4 and 5 • The product is capable of simulating queuing models without having to program – the model is created on the screen by using graphic icons which is later analysed by a Queuing Model Generator (QMGW) • Considering the price it is worth experimenting
11 SDI Industry, SDI Industry Pro, SDI Industry Chain	Win 95/98/NT	USD1,495 - USD3,495 (Australian supplier quoted AUD142,880 for the entire package)	Discrete event simulation for process orientated industries
12 SimLogic	Win 95/98/NT	$345-$645 (see also SimSheet)	This is a discrete event simulation capabilities suitable for general purpose applications – can work with Visio
13 SIMPROCESS	Win 95/98/NT	Max USD100,000.00 or USD40,000.00 for 5 licenses	• The product is based on OO simulation language with GUI • It combines process mapping, discrete event simulation and Activity Based Costing (ABC) in a single tool • It provides simplified flowcharting, spreadsheet and project management software
14 SIMSCRIPT	Win 95/98/NT, Unix, Linux	Ranging from USD25,000 to USD35,000 (depending on OS) and a fixed maintenance fee.	• The product is based on OO simulation language with GUI • It is a simulation programming language for network optimisation and linear programming • It provides developers with free-form, English-like simulation and modelling language • It is self-documenting
15 SimSheet	Win 95/98/NT	USD199 - USD299 (Max USD3995 – USD4995 depending on OS)	• The products is a general purpose discrete even simulation software • It is capable of providing graphical interface • It adds simulation capabilities to spreadsheet for planning, analysis and so forth
16 Simul8 Professional	Win 95/98/2000/NT	USD6595.00 Simul8 Standard Edition USD995.00	• This is a visual discrete event simulation • It can simulate business processes • It maps into Visio • It can communicate with applications such as Excel, VBA, VB, C++, Delphi and any other ActiveX/COM supporting software • The product supports SQL database connectivity • It allows for template licensing (license your own simulation to stop others altering your work through turning off certain toolbars • It provides resources and templates for fast simulation
17 Taylor II Simulation Software	Windows	$8,000	To be further investigated