Developing a Simulation Model for a Level of Usage

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***Abstract*— This paper provides a framework categorising the level of usage of a simulation model and relating this to three key activities in the simulation process of model development, model interaction, and model integration. The aim of the framework is to clarify how the level of usage will decide both the nature of the information derived from the simulation study and the development activities that are required of the model builder. Further work is required in order to determine if in practice the level of usage is determined by the level of information required or other factors, such as a lack of user skills is preventing a higher level of usage of the technique in the organisation.**

Keywords-simulation; methodology; development

I. INTRODUCTION

There are many texts available on the topic of discrete-event simulation modeling. Some texts focus on technical and statistical aspects [1,2], other texts focus on the application of simulation for process analysis [3,4], other texts provide tutorials on particular simulation software platforms, such as ARENA [5,6,7], and other texts take the reader through the steps involved in undertaking a simulation study [8,9,10,11,12,13]. However, all of these different approaches generally provide little guidance on the form of the simulation that is appropriate to the needs of the study. This should be considered in terms of viewing simulation as a tool which provides information to assist in decision making. It follows that in order to assist the decision-making process it is not always necessary to undertake all the stages of a simulation study. For instance, the development of the process map may be used to help understanding of a problem and consequently, no further model development is necessary.

The paper will provide an overview of proposed forms of simulation development. Four forms are identified and labeled on a continuum of levels of usage of the simulation technique. The forms are defined by three variables related to key aspects of the simulation project effort of development, interaction, and integration. There is then a discussion of these forms and an indication of further research required in order to validate these forms.

II. DETERMINING THE LEVEL OF USAGE OF THE SIMULATION MODEL

An important aspect in the process of building a simulation model is to recognize that there are many possible ways of modelling a system. Choices have to be made regarding the level of detail to use in modelling processes and even whether a particular process should be modelled at all. The way to make these choices is to recognize that before the model is built, the objectives of the study must be defined clearly. It may even be preferable to build different versions of the model to answer different questions about the system, rather than build a single 'flexible' model that attempts to provide multiple perspectives on a problem [14]. This is because two relatively simple models will be easier to validate and thus, there will be a higher level of confidence in their results than a single complex model.

The objective of the simulation technique is to aid decision making by providing a forum for problem definition and providing information on which decisions can be made. Thus, a simulation project does not necessarily require a completed simulation model to be a success. At an early stage in the project proposal process the analyst and other interested parties must decide the role of the model building process within the decision-making process itself. Thus, in certain circumstances as stated earlier the building of a simulation model may not be necessary. However, for many complex interacting systems (i.e., most business systems), the model will be able to provide useful information (not only in the form of performance measures, but indications of cause and effect linkages between variables), which will aid the decision making process. Table 1 provides a framework which links four categories of usage of the simulation model, namely 'problem definition', 'demonstration', 'scenarios' and 'on-going decision support' with three key aspects of the simulation process. These three key aspects are the level of development of the model, the level of interaction between the model and user, and the level of integration of the model with its data set that would be implied by the level of usage.

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TABLE I. LEVELS OF USAGE OF A SIMULATION MODEL

	Level of Usage			
	Problem Definition	**Demonstration**	**Scenarios**	**On-going Decision Support**
Level of Development	Process Map	Animation	Experimentation	Decision Support System
Level of Interaction	None	None Simple Menu	Menu	Extended Menu
Level of Integration	None	Stand-alone	Stand-alone Database	Stand-alone Database Real-Time Data

The levels of usage categories are defined as follows:

A. Problem Definition

One of the reasons for using the simulation method is that its approach provides a detailed and systematic way of analysing a problem in order to provide information on which a decision can be made. It is often the case that ambiguities and inconsistencies are apparent in the understanding of a problem during the project proposal formulation stage. It may be that the process of defining the problem may provide the decision makers with sufficient information on which a decision can be made. In this case, model building and quantitative analysis of output from the simulation model are not required. In terms of development, the outcome from this approach will be a process map of the system. As no model is constructed the level of model interaction and model integration categories are not relevant.

B. Demonstration

Although the decision makers may have an understanding of system behaviour, it may be that they wish to demonstrate that behaviour to other interested parties. This could be to internal personnel for training purposes or to external personnel to demonstrate capability to perform to an agreed specification. The development of an animated model provides a powerful tool in communicating the behaviour of a complex system over time. Here, the model should be developed to such as level as to enable the presentation of a realistic animation of the process. This will reveal the mechanics of process behaviour over time but will not provide a numerical indication of performances which are provided by the experimentation analysis undertaken in higher levels of usage. In terms of interaction, a simple menu system may be useful in providing a convenient method of altering parameters for the animation.

However, there is unlikely to be a need for integration with external data sets, due to the lack of scenario analysis when used in the demonstration mode.

C. Scenarios

This category of usage can be related to the ‘classic’ or ‘textbook’ use of the simulation method. Here, the model is developed, validated and scenario analysis conducted. Results are presented of performance measures of interest usually in the form of confidence intervals. In the scenario category, the model is used to solve a number of pre-defined problems but is not intended for future use. For this reason, in terms of the level of interaction, a menu system allowing change of key variables may be appropriate. In terms of integration, the simulation may use internal data files or ideally be linked to external databases.

D. On-going Decision Support

The most fully developed simulation model must be capable of providing decision support for a number of problems over time. This requires that the model be adapted to provide assistance to new scenarios as they arise. The menu system will need to provide the ability to change a wider range of variables for on-going use. The level of data integration may require links to company databases to ensure the model is using the latest version of data over time. Links may also be required to real-time data systems to provide on-going information on process performance. If it is envisaged that the client will perform modifications to the simulation model after delivery, then, the issue of model re-use should be addressed. Re-use issues include ensuring detailed model code documentation is supplied and detailed operating procedures are provided. Training may also be required in model development and statistical methods.

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III. DISCUSSION

A simulation modelling project can use extensive resources, both in terms of time and money. Although the use of simulation in the analysis of a one-off decision, such as a major investment appraisal, can make these costs low in terms of making the correct decision, there is a need to ensure the correct level of usage is chosen in alignment with the information required for the decision. Indeed, it has been noted that it is not a requirement of a simulation modelling exercise that a model is actually built, but qualitative outcomes from the process mapping stage, for example, could generate useful knowledge. This elicitation of knowledge through the process of conducting a simulation study rather than simply an observation of model results is termed 'simulation for facilitation' by Robinson [15]. On the other hand, the advantages of a higher level of usage may be considerable in terms of a greater amount of information gained as the level of usage is increased and there is also evidence that developing a model with on-going decision-support capabilities increases model confidence and acceptance particularly among non-simulation experts [16]. However, the consequences of developing a model with a high level of usage in terms of model development, interaction and integration should be considered. The use of simulation for on-going support is particularly challenging and it is thus important that during the project proposal stage that elements are incorporated into the model and into the implementation plan that assist in enabling the model to provide on-going decision support. Aspects include ensuring that simulation users are aware at the project proposal stage that the simulation is to be used for on-going decision support and will not be put to one side once the immediate objectives are met. Also, ensuring technical skills are transferred from simulation analysts to simulation users will enable understanding of how the simulation arrives at results and its potential for further use in related applications.

To assist in the identification of the form of simulation that users adopt, a framework containing four levels of usage of simulation has been presented. It is proposed that a survey be conducted to establish the validity of these forms and the proportion of use of each of the four levels of usage. The aim will be to establish if there is a match between the level of usage and the information needs of the decision being taken or if there are other factors, such as lack of skills, impacting on the choice of level of usage.

IV. CONCLUSION

This paper aims to highlight an important aspect of conducting a simulation study, namely, the level of usage of the simulation model. This issue is important because it will decide both the nature of the information derived from the study and the development activities that are required by the model builder. Further work is required in order to validate the level of usage by practitioners and their implications for the simulation process. An important question is to determine why the different forms are utilised. For instance, is the level of usage determined by the level of information required or is it that the lack of user skills is preventing a higher level of usage of the technique in the organisation?

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