Proceedings of the 1985 Winter Simulation Conference
D. Gantz, G. Blais, S. Solomon (eds.)

INTERACTIVE CONTROL OF THE MODEL: A NATURAL COMPANION TO ANIMATED SIMULATION GRAPHICS

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ABSTRACT

Many recent publications have lauded the value of an animated graphical representation of a simulation model as a boon to communicating model results to decision makers. Recent commercial product developments reflect the importance the simulation community places on graphical representations. This paper suggests that the use of animated graphics is a step in the right direction but leads naturally to another step: interactive control of the model.

It is now generally recognized that a decision maker is more comfortable with recommendations based on a simulation model that he has "seen". The natural tendency for a manager who sees the manifestation of a problem (eg. an overflowing WIP buffer) in a simulation animation is to immediately respond "what if we ..." If the model provides immediate access to his suggested change through interactive facilities, then the flow of ideas from the decision maker is greatly enhanced. The decision maker begins to get a feel for the system's responses. This does not replace the need to perform more controlled experiments to determine long run tendencies of the model. That is a task different from acquiring the confidence of the decision maker.

Another benefit of interactive models is explored in this paper. There are times that we would like the manager's input to the model for the model's sake rather than the manager's sake. Many models contain some element of human decision making. The decision function is typically simplified into a series of logical conditions for the sake of coding. An interactive model provides a means for the computer and human to work together to achieve a more realistic model. Rather than going through the trouble of simplifying and coding human decision making, let the real decision maker provide the decision through interactive facilities when the model requires a decision. Let the human do what it does best, and let the computer do what it does best, ie. repeatedly process the systematic rules of the model.

There are several advantages to models that can provide an animated graphical representation of the system being modeled. The modeler often benefits; more important though, the decision making process benefits. The purpose of this paper, however, is not to report claims about graphics and animation. Its purpose is to demonstrate that animated graphics, combined with interactive control of model characteristics, bring benefits that are greater than the sum of these two features considered separately. In particular, this paper will challenge the traditions of batch type models with two valuable uses for interactive model control. The first focuses on the needs of the decision maker whom the modeler seeks to help. The second exploits interactive capabilities as a means to a more realistic, as well as simpler, model.

THE NEEDS OF THE DECISION MAKER

Why is simulation so often applied to problems? For the audience of this paper the answer is obvious: to gain insight to the behavior of a system so that better decisions can be made about the system. Decisions invariably involve decision makers and these people are most often not simulation practitioners. However, that doesn't mean they aren't intelligent. When presented with a recognizable simulation animation, coupled with graphically displayed performance statistics, they are capable of learning a lot about the performance of the system under the simulated conditions. The information they can digest while "viewing" such a simulation run will represent a quantum leap over what they could gain from tabular performance statistics. Put simply, graphics communicate better than figures.

In such a scenario, both modeler and decision maker can now easily understand model performance. Recalling the objective of simulation, we are seeking insight to the behavior of the system. How do we gain insight? We gain insight through experimentation with the model. Recall the decision maker, he is intelligent. He is capable of experimenting with a model he understands. In fact, when he is responsible for the real system he has a great incentive to experiment. If the model he has been viewing retains the batch nature of traditional non-graphic models, immediate experimentation is not possible and the decision maker is stymied. Watching the simulation has prompted a series of ideas, experiments he would like to try. These will be the "what if" type of questions simulation practitioners are familiar with. They will likely be better, more informed questions, and experience with graphic models has shown this to be true.

To answer the questions in a batch environment the modeler must return to the source code for a series of modifications reflecting the "what ifs". In all probability, this will mean scheduling another session with the decision maker to demonstrate the results. It will be an exceptional manager indeed that has not lost his train of thought from the first session. What he really wanted was the answers to the questions when he asked them.

A decision maker's time is best spent in a session with the model and modeler where most or all of his concerns can be answered. He will have concerns ranging from how well the model represents the system to how thoroughly different strategies were tested to overcome problems uncovered by the model. Animated graphics is the first step. The ability to implement "what if" changes to the model immediately is the obvious next step. This suggests that a model that makes possible interactive changes to model parameters, and even model logic, would ultimately be more valuable to the decision maker. Interacting with a model to carry out his ideas can allow the decision maker to convince himself of the decisions the model suggests. If he must wait for the modeler to go away and change source code, his flow of ideas is seriously impeded. The process of batch simulation interferes with the decision maker's attempts to learn the responses of the model and, ultimately, his confidence in the recommendations of the modeler.

A distinction must be drawn between the value of interactive model control for communicating with decision makers and the simulation practitioner's traditional role of model experimentation and analysis. This role has not changed. Many aspects of the practitioner's role in experimentation may, in fact, be made easier with interactive model control. Carrying out controlled experiments to determine the long run tendencies of the model, and making recommendations based on the results, remains the province of the modeler.

It is when the modeler must make the informed recommendations to the decision maker that the interactive model is so valuable. Such meetings rarely find the decision maker blindly accepting the recommendations of the modeler. There will be a two way exchange of information. With an interactive model as the center of the discussion, both sides can make their points more easily. The decision maker can convince himself whether or not all angles have been considered. The modeler can make plain the assumptions and simplifications of the model. He can lead the decision maker through the analysis, if necessary, that lead to his recommendations. Together they can determine the value of the recommendations, the limitations of the model, and whether further work on the model, the system design, or both must be considered.

It would be hypocritical to suggest that the value of visual interactive models could easily be communicated in the text of a paper. The author's appreciation of such models comes from experience with SEE WHY, a simulation package designed explicitly for the development of visual, highly interactive, models. The attraction of such models is easily apparent to decision makers whether or not they are familiar with the technique of simulation. The features of visual interactive models make the work of the simulation practitioner more saleable. The reader is encouraged to experience visual interactive models with an eye towards the ready acceptance they find with decision makers.

MODELING HUMAN DECISION MAKING

The second focus of this paper is a way in which modelers can use interactive models to improve and, at the same time, simplify their models. Visual interactive models make possible many new relationships between man and model. One such relationship is the use of the man as an integral part of the model. Human decision making is frequently a stumbling block in the coding of a model. Some part of the real system relies on a human decision and the model must attempt to mimic that decision. Batch models dictate that the model must approximate human logic so that the model can be run. Interactive models don't have that restriction; a human can supply the decision when necessary. The purpose of this section of the paper is to convince modelers to keep their minds open to this technique.

Consider why computers are used in the modeling process. Computers are good at repeatedly executing a set of rules for manipulating the modeling elements (entities, etc.). Some of the rules the modeler includes in the model are in fact rules in the real system. They are systematic in nature. They are dictated by the characteristics of a physical process and/or the controlling system software. Being systematic, they are easy for the modeler to mimic in the model.

Other rules found in the real system are less systematic by nature. They are human decisions and computers have not been good at mimicking them. In fact, a whole new discipline in computer science, namely artificial intelligence, has evolved because computers have been poor substitutes for human decision making. Anyone who has tried to model human logic in a model with traditional programming techniques knows that it is an unsatisfying task. It is the tradition of batch simulation that has forced modelers to use a poor substitute for human logic.

An example might make the modeler's dilemma more clear. Consider a model of an airport aimed at investigating throughput of the runways. How this system behaves hinges on the decisions of the air and ground traffic controllers. Is it reasonable to assume that a modeler can use a series of logical conditions to replicate the controller's logic in all situations that he faces? It will certainly take the modeler a long time to implement the logic. At best he will have a model that provides an equivalent decision under certain conditions. Why bother with the exercise at all?

Visual, interactive models provide a neat solution to the problem. When human decisions are required the model should stop and prompt the user for the required decision. The model must be visual so that the user can easily assess the current situation. A human can always provide a decision that is as good or better than a program designed to mimic human thought. The model may be required to display data pertinent to the decision, but it need not contain cumbersome logic. The model is simpler and, at the same time, more robust. Of course, it won't run without human interaction, but neither will the real system. Any serious attempt at modeling systems with integral human decision making must consider how best to represent it in the model. With interactive modeling as an option the solution can be simple.

It is hoped that this paper has made apparent the synergy of graphics and interactive capabilities in the application of simulation to real life systems. A nonvisual model simply does not invite interaction because the current state of the model is not easily apparent. Adding animated graphics makes plain the current model state and encourages questions and suggestions. Without the facilities to interact the full value of the graphics is sacrificed because the questions remain unanswered. As case examples are difficult to relate in text, and the very theme of this paper suggests this, the reader is encouraged to seek demonstrations of visual, interactive models to convince himself of their worth.

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