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ANIMATED SIMULATION MODELS : MIRACLE OR MENACE

P S KRUGER

Centre for Computer Integrated Production Systems
Department of Industrial and Systems Engineering
University of Pretoria
Pretoria
SOUTH AFRICA

ABSTRACT

There has been a dramatic increase in the use of computer based simulation modelling over the last decade. A development that has made a significant contribution to the popularity of the simulation approach is the availability of animation facilities. These facilities are usually part of simulation model development software and often do not require very expensive microcomputer equipment.

Animation provides some significant advantages during most phases of a simulation modelling effort but also has some inherent dangers and pitfalls. The purpose of this paper is:

- to identify and discuss some of the more important advantages and disadvantages of animation, and
- to provide information about some of the available simulation model development software supporting animation capabilities.

INTRODUCTION

There has been a dramatic increase in the use of simulation modelling for analyzing, designing and "optimizing" manufacturing, materials handling, management, commercial and a wide variety of other systems. One reason for this trend may be the growing need for increased productivity through more effective high quality decision making caused by the increased technological complexity of modern systems. Another aspect that may play a role is the continuously decreasing cost and increasing power of the available computer hardware and software. One particular example being the availability of animation facilities as part of simulation model development software. These packages often do not require very expensive microcomputer equipment.

During the last decade the graphic capabilities of microcomputers have been enhanced significantly to the extent where the use of graphics has become commonplace in many computer applications. Static graphics capabilities, such as plots, barcharts and histograms, have been part of most simulation packages for some time and are used routinely as part of output reports. The availability of dynamic graphics or animation is a more recent development exploiting the readily available graphic capabilities of microcomputers to a much larger extent. Animation is a supplemental way of displaying output from a simulation model. It should never be seen as a replacement for the more traditional way of presenting output such as aggregated statistics and static graphics.

A bewildering variety of simulation/animation software packages is at present available. Packages such as GRASP [1] or Autodesk Animator [2] are almost exclusively intended for producing lifelike screen animations and provide very limited or no modelling support. Simulation languages such as SIMPLE_1 [12:153] or MicroSaint [12:146] are primarily model building tools with limited animation facilities. Products such as Automod II [9] and Witness [9:32] provide comprehensive model building and animation capabilities but are rather expensive and require specialized computer hardware. SIMAN/CINEMA [12:139] and SLAMSYSTEM [9] are both based on powerful, general purpose and popular simulation languages (SIMAN and SLAM respectively). These packages provide sophisticated animation facilities, require standard computer hardware and are available at affordable prices.

Figure 1 shows a snapshot of a typical animation screen, based on a simple model, developed with SLAMSYSTEM.

Similarly, figure 2 shows a snapshot of a typical animation screen, based on a more complex model, developed with SIMAN/CINEMA [7].

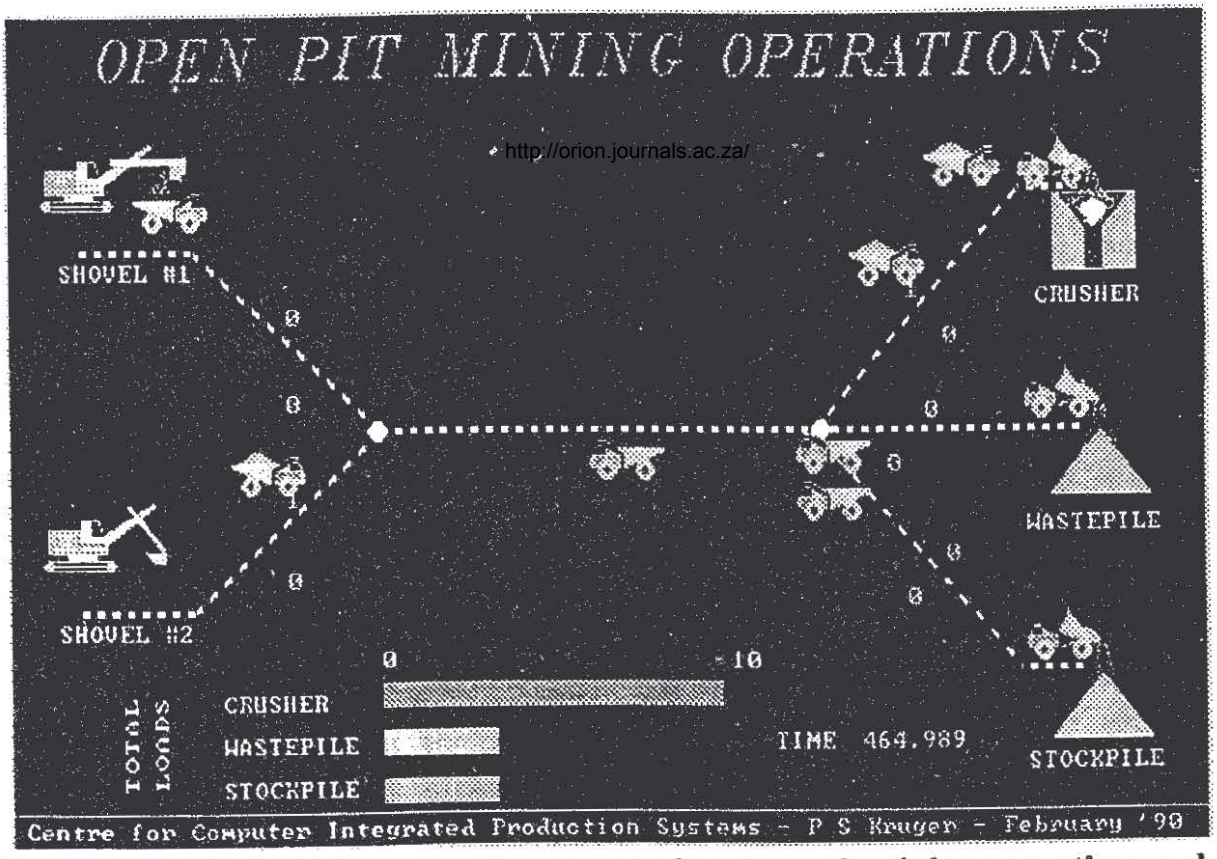

Figure 1 SLAMSYSTEM animation screen of an open pit mining operation model

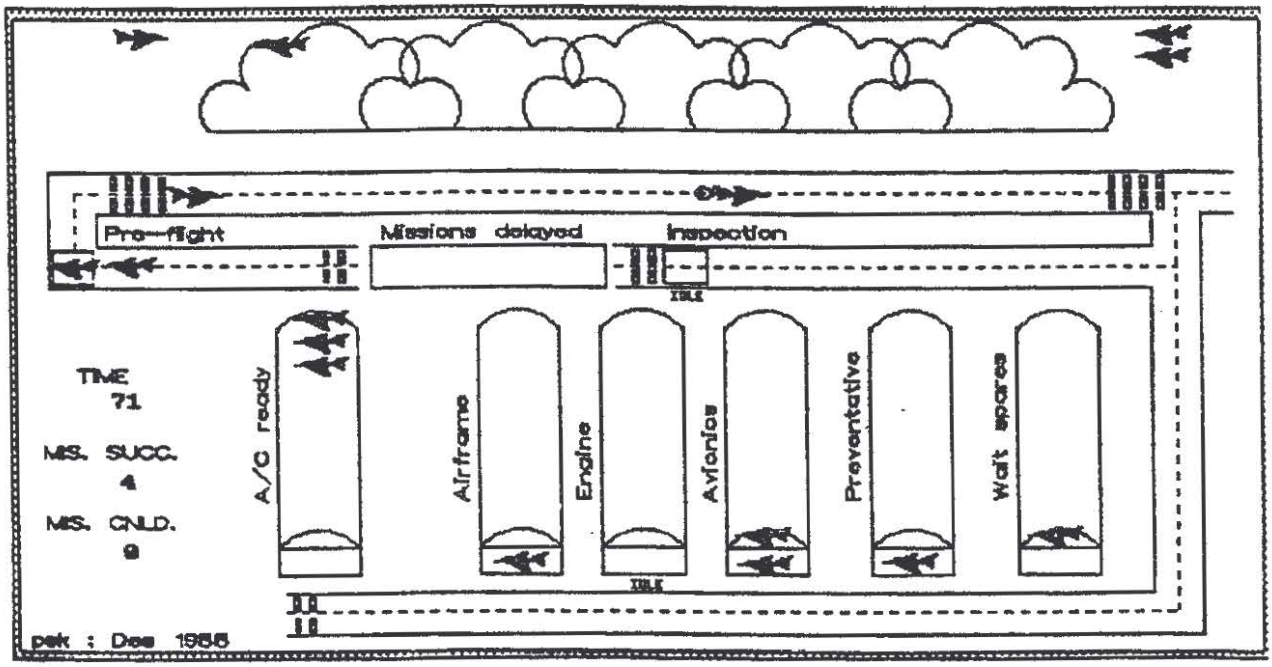

Figure 2 SIMAN/CINEMA animation screen of an air force squadron model

Animation provides some significant advantages during most phases of a simulation modelling effort, from initial coding and debugging of a model through the processes of verification, validation, the interpretation and presentation of results and especially the communication between the model builder and the user. However, the use of animation also has some inherent dangers and pitfalls that the potential user should be aware of and try to circumvent.

DISADVANTAGES OF ANIMATED SIMULATION [3,5,8]

Building an animated simulation model may imply a significant increase in the total project cost compared with a simulation model without animation. Animation software packages are usually substantially more expensive than the simulation language on which they are based. Furthermore, animation will require some additional time and effort and may require additional hardware.

Animation does not replace standard statistical output analysis and is only an optional way of displaying simulation output. The final answers, for decision making purposes, are not obtained from the animation but rather from analysis of the model output in the normal way.

An ever present possible misuse and inherent danger of animation may be described as the "fifteen minute" or "snapshot" analysis. Observing an animation of a stochastic system for a short period of time may easily lead to erroneous conclusions since it is not based on a statistically representative sample.

Another possible misuse of animation is the difficult to resist temptation to over-model. This may result in an inappropriate increase in modelling detail with the sole purpose of creating a more realistic animation. Sound modelling practice dictates that just enough detail should be included to address correctly those issues that are important for modelling purposes. An inappropriate level of detail may result in either an invalid model or a model requiring unnecessary long execution times. Apart from the obvious increase in project cost resulting from such over-modelling, a real danger exists in that it may increase the probability of coding and other logic errors in the model. Animation should always be of secondary concern compared with the primary purpose of building a valid model.

A realistic and aesthetically beautiful animation may create the impression that the underlying model is more realistic and valid than what is actually the case. This may lead to

a false sense of security about the validity of the model. It should always be remembered that a realistic looking animated model is still a simulation model and all the rules for building good models must still be followed. The inherent assumptions and simplifications of the simulation model do not disappear because of a beautiful and very realistic looking animation.

ADVANTAGES OF ANIMATED SIMULATION [3,4,5,8,11]

The primary benefit and greatest contribution of animation to the art of simulation is the resultant increase in effective communication between model builder and user. Through animation it is possible to display intricacies of system interaction that can never be achieved by using tables, aggregated statistics or static graphs. In this way it is much easier to obtain the necessary high level of model credibility amongst users who may not be simulation modelling experts. Similarly, it is very important to interact with management, or the client, on a regular basis during all phases of model building. Using an animated model makes this kind of interaction significantly easier.

Animation makes it easier for system specialists, with little or no knowledge of simulation, to become involved in the modelling exercise. They also may be able to suggest modifications or generate ideas for design changes as part of the model building process. This may make significant contributions to the difficult process of model validation and may result in a model that enjoys greater acceptability by potential users. Similarly, validating a model of a non-existing system is often heavily dependent on the interaction and opinion of system experts. Without the help of animation, soliciting the cooperation of such system experts is often a difficult and arduous task.

An animation may make it possible to discover and identify small but potentially disastrous model defects that may otherwise be very difficult to detect. It is often possible to trace and find ways to eliminate the root causes of such defects even using a very simple schematic animation. Animation may therefore make a worthwhile contribution to the reduction in model building time by providing an effective model debugging and verification tool.

An animated model makes it possible to see the dynamic interactions of many simultaneous and interrelated events. Furthermore, it provides a view of the system as a whole. In this way it creates an awareness of both the dynamic and stochastic nature of the system and also the importance of interactions between different sub-systems. This may provide additional insight into the structure of a complex system.

Part of most modelling exercises consists of the presentation of the model results. Using animation to supplement the normal statistical and static graphics output enhances the credibility and acceptance of a model and therefore also the effective use of such a model. Animation has proved to be a very effective selling tool since a picture, especially a moving one, is worth much more than the written word or static graphics.

One of the worthwhile applications of simulation is the use of such a model as a training or teaching aid. An interactive animation may improve the value and usefulness of such an aid substantially.

Animation may aid in making quicker or better decisions about the system under investigation. However the true contribution of animation to decision making is probably very limited and final decisions should rather be based on comprehensive numerical output analysis.

ANIMATION SOFTWARE [9, 12]

Over the last decade there has been an explosion in the number of available simulation packages. At present a significant number of these packages provides animation capabilities of one kind or another. Choosing a package with animation capabilities is an important but also difficult decision to make.

It is an important decision since the required hardware and software may not be inexpensive. Furthermore, the amount of time, effort and money involved in training personnel to reach a high level of proficiency in the use of a specific package may be substantial. Once this expertise has been attained it may not be easy or cost effective to change to another software system.

However, the bewildering variety of available choices in terms of technical capabilities, ease of use and cost makes it very difficult to choose the most appropriate package. The situation is further exacerbated by the frequent introduction of new versions of existing products and even completely new products.

Many aspects may play a role in choosing an animation system. These aspects are not mutually independent, nor are they independent from the underlying simulation language, and their relative importance may differ from one application environment to another. The following provides a list of some of the aspects that should be considered in choosing a simulation/animation system :

The characteristics of the underlying simulation language

- The power, flexibility and ease of use of the simulation language, for example the capability to handle both discrete and continuous models.

- The relative merits of a general purpose versus special purpose language in the specific application environment.

- The special hardware that may be required, for example expanded/extended memory.

- The modelling support software provided or required, for example a general purpose low level programming language.

- The limitations on model size or complexity that may exist.

- The model execution speed of the specific language given a specific hardware configuration.

- The transportability of models between different computer classes, for example between a microcomputer and a mainframe.

- The debugging facilities provided by the language, for example an interactive debugger.

- The availability of on-line help.

- The capabilities to interface with other software, for example a general purpose low level programming language.

- The statistical capabilities, for example random number generation and the acquisition of output statistics.

- The output report generation capabilities, for example standard or user specified summary reports.

- The support provided for statistical output analysis, for example the calculation of confidence intervals.

- The capabilities provided for simulation run time control, for example independent replications.

- The special modelling features provided, for example materials handling modelling capabilities.

The characteristics of the animation capabilities

- The special hardware requirements, for example the graphics monitor.

- The ease of development, for example background screen and symbol generation.

- The power and flexibility of the graphics editor and other development support features.

- The quality of graphics, for example character or bit-map graphics.

- The ease of interfacing the animation with the underlying simulation language.

- The available support for multiple background animation screens, pan or zoom capabilities.

- The availability of concurrent or postprocessing of animation output.

- The capabilities to interfacing with other graphics software, for example other CAD-software.

Other global characteristic of importance

- The skill and experience of the available personnel.

- The capability of imbedding the simulation model in other software systems and to create application specific user-interfaces.
- The quality of the software documentation.
- The availability of customer support.
- The availability of local training.
- The total expected cost of hardware, software and training.
- The software development philosophy of the vendor.

Table 1 provides some information about some simulation model development packages providing animation capabilities.

CONCLUSIONS

It should be realized that in acquiring a simulation/animation package one is not only buying an animation capability but a complete simulation system including the simulation language and its limitations. Furthermore, the final answers from a simulation study are not obtained from the animation but rather from a well designed simulation model using traditional statistical output analysis.

However, including an animation capability as part of a simulation study may make the difference between acceptance or rejection of the recommendations and therefore the difference between success or failure of the project. The impact of animation, as part of the output of a simulation model, on the uninitiated and sceptical user/client should never be underestimated.

	GPSS/PC	SIMAN/ CINEMA	SIMPLE_1	SIMSCRIPT	SLAMSYSTEM	PC/MODEL
Approximate Cost	$1000 to $2000	SIMAN $3000-$8000 SIMAN/ CINEMA $20000-$30000	$750	$14000 to $80000	$20000	$1000 to $4000
Low level language interface	No	Fortran and C	No	No	Fortran	No
Discrete and Continuous	Yes	Yes	Yes	Yes	Yes	No
Statistical output processing	Yes	Yes	No	No	No	No
Modelling approaches supported	Process interaction	Process interaction and Event scheduling	Process interaction and Event scheduling	Process interaction and Event scheduling	Process interaction and Event scheduling	Process interaction and Event scheduling
Graphics	Character and Bit-mapped	Bit-mapped	Character and Bit-mapped	Character and Bit-mapped	Bit-mapped	Bit-mapped
CAD-interface	Yes	Yes	No	No	Yes	No
Hardware equipment required & operating system	IBM XT, AT or 386 MS-DOS	IBM XT, AT or 386 Apollo, Sun MS-DOS,OS/2 Unix	IBM XT, AT, or 386 MS-DOS	IBM XT, AT or 386 Workstation MS-DOS Unix etc.	IBM AT or 386 MS-DOS & MS-Windows	IBM XT, AT or 386 MS-DOS
Vendor name address and telephone	Minuteman Software P O Box 171 Stow MA, 01775 USA (508)8975662	Systems Modelling Corporation The Park Bld 504 Beaver Street Sewickley PA, 15143 USA (412)7413727	Sierra Simulations Software 303 Esther Avenue Campbell CA, 95008 USA (408)3786374	CACI 3344 North Torrey Pines Court La Jolla CA, 92037 USA (619)4579681	Pritsker Corporation P O Box 2413 West Lafayette IN, 47906 USA (317)4635557	Simulation Software Systems 2107 North First Street Suite 680 San Jose CA, 95131 USA (408)4368300

Table 1 Characteristics of some simulation modelling software providing animation capabilities

As is the case with many techniques based on the concept of modelling, a real need exists to "sell" the simulation model to the potential user/client. At present animation represents the best available tool for this purpose, especially to obtain the very important initial breakthrough. However, the animation should always be backed up by a sound and well designed simulation model.

REFERENCES

1. *BYTE*, February 1989, p 32.
2. *BYTE*, December 1989, p 74.
3. GRANT J W and WEINER S A, 1986, Factors to Consider in Choosing a Graphically Animated Simulation System, *Industrial Engineering*, Vol 18, No 8, August 1986, pp. 37-68.
4. HENZ LUEHRMANN M A and BYRKETT D L, 1989, A Pilot Study of the Impact of Animation on Decision-making, *Simulation*, Vol. 53, No. 4, October 1989, pp. 153-158.
5. JOHNSON E, 1988, Computer Animation in Discrete Event Simulation Modelling : A Healthy or Hazardous Addition to the Modeler's Toolbox ?, *Simansez*, No 8, Summer 1988, pp. 4-5.
6. KRUGER P S, 1986, Dynamic Graphic Animation of Simulation Model Results, *Transactions - SACAC/ORSA-Simulation Symposium*, 11-12 March 1986.
7. KRUGER P S and SCHUTTE C S L, 1990, Simulation Modellingas a Tool for Performing Availability and Sensitivity Analysis, *Third Systems Engineering Convention*, CSIR, Pretoria, 21 May 1990.
8. LAW A M and McCOMAS M G, 1989, Pitfalls to Avoid in the Simulation of Manufacturing Systems, *Industrial Engineering*, Vol. 31, No. 5, May 1989, pp. 28-69.
9. LAW A M and HAIDER S W, 1989, Selecting Simulation Software for Manufacturing Applications : Practical Guidelines and Software Survey, *Industrial Engineering*, Vol. 31, No. 5, May 1989, pp. 33-46.
10. LAW A M, 1986, Introduction to Simulation : A Powerful Tool for Analyzing Complex Manufacturing Systems, *Industrial Engineering*, Vol 18, No 5, May 1986, pp. 46-63.
11. SMITH R L and PLATT L, 1987, Benefits of Animation in the Simulation of a Machining and Assembly Line, *Simulation*, Vol 48, No 1, January 1987, pp. 28-30.
12. SIMULATION COUNCILS, INC., 1988, Catalog of Simulation Software, *Simulation*, Vol 51, No 4, October 1988, pp. 136-156.