TEACHING BUSINESS DECISION MAKING USING A SIMULATOR

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ABSTRACT

Computer simulation in business decision support systems (DSS) has come of age and is the "first choice" method of problem analysis and solution. Unfortunately, business students are reluctant to learning an additional computer language for DSS model building. However, recent development of numerous simulation/animation PC packages and particularly the no programming Simulators has greatly enhanced a users efficiency and effectiveness in problem solving. Business schools must fully adopt this new technology into their DSS curriculum. Simulation is a powerful decision support tool for solving almost all business problems.

INTRODUCTION

Simulation, as a modeling media for DSS that structure solutions for multiple criteria decision making (MCDM), has aided business decision makers in making choices among multiple alternatives since the early 1960's. Corporate surveys relative to use of quantitative techniques for DSS in MCDM indicate that simulation has rapidly become the preferred decision modeling method. (see Chen, 1981; Harpell, Lane, and Mansour, 1989)

Even though simulation was in the past considered the "tool of last resort" in DSS due to the difficulty of defining and programming the problem(s), this limitation has been remedied by new object-oriented-programming (OOP) simulation languages referred to as no programming Simulators. (see Banks, Aviles, McLaughlin, and Yuan, 1991) Industry applications of simulation modeling are exploding, however, business schools have been reluctant to adopt simulation as an important DSS tool (see Simulation in Business Schools section). It is critical that this "leading edge" technology be integrated into the business school curriculum to prepare students for their future real world experiences.

SIMULATORS

Simulators are distinguished from other simulation languages by their use of icons whose characteristics are parameter defined (encapsulated), have the ability to inherit attributes from other icons, and are poly-morphic in nature. Simulators also require little or no programming and are utilized through pull-down menus from which a) icons are selected and defined and b) the specific construct of the decision model are graphically linked. The following Table 1 summarizes the simulation languages and the new simulators.

Shapiro (1990) aptly expressed the philosophy of the microcomputer simulation language trend in his review of the Simulator Micro SAINT; "The goal of the developers of Micro SAINT is to provide an environment for creating simulation models suitable for the analyst who is not a continual creator of simulation programs, or who does not

Event-Scheduling	Process-Interaction	Simulators
SIMSCRIPT	GPSS	MAST
GASP	SIMULA	AutoMod
	Q-GERT	WITNESS
	GPSS/H	XCELL+
	GPSS/PC	SIMFACTORY
	SLAM	Micro Saint
	SIMAN/CINEMA	STARCELL
	SIMSCRIPT II.5	MIC-SIM
		ProModelPC
		Extend
		SIMOBJECT

TABLE 1
Simulation software (Banks et al., 1991)

have training in a simulation programming language."

A review of Extend for Macintosh by Crabb (1988) demonstrated the marriage of OOP and simulation modeling. The user of Extend no longer is required to decompose the problem into its constituent parts but is primarily concerned with objects that need to be manipulated and how they can be manipulated. The user is provided an integrated environment with a graphics window from which they can a) run existing simulations from their block diagrams, b) build new simulations from libraries of existing blocks, or c) create new block diagrams entirely.

CACI products company has developed a number of simulation languages during the last 10 years. One of their recent products, SIMFACTORY, is a true simulator. This software package has eight preprogrammed icons for describing a production process. However, the user is not limited to the existing icons but can create any number of additional icons through the use of the SIMGRAPHICS portion of the program. To edit the model, the use only has to revise the parameters of one or more icons. Therefore the use of the model to make "what if" decisions is almost unlimited. See Figure 1 below for an example of SIMFACTORY.

In August, 1991, CACI Products Company introduced a graphical aid to simulation model construction called SIMOBJECT. This software package enables the user to graphically construct complete OOP simulation models, with little or no user programming, which are compatible with their current

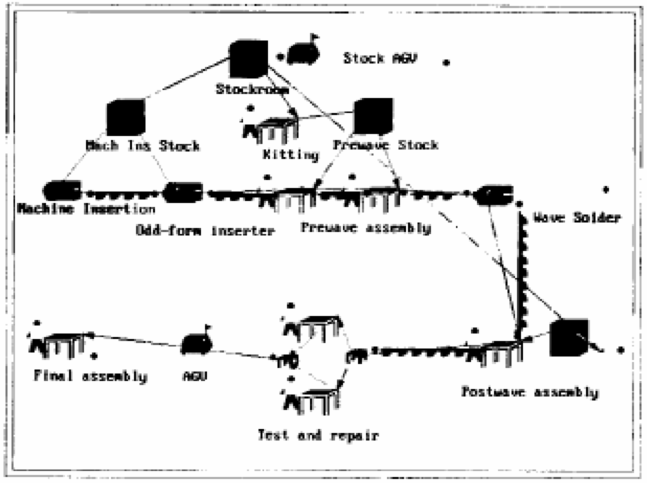

FIGURE 1
SIMFACTORY animation/icon layout

simulation languages MODSIM II and SIMGRAPHICS II

Cynar and Tran (1991) have written a new PC simulation package for use in teaching global modeling techniques in a graduate simulation course. The software was written in C and uses Windows to create the flow diagrams for the model of interest (OOP). The user uses the mouse to select the desired model symbol and to place it on the flow diagram. After the model is completed, pull-down menus are used to select the desired output, assign values to parameters and to run the model.

A similar block flow diagram programming capability is also available in the simulation language SIMAN 4.0 and the associated graphics package CINEMA. However, these are not OOP languages.

A review of SIMFACTORY, XCELL+, WITNESS, and ProModelPC by Banks et al. (1991) revealed the strengths and weaknesses of these Simulators. Of these four packages XCELL+ is the most difficult to use and the most limited in application. WITNESS and ProModelPC have the most features and require no programming in order to build a simple model.

As new developments take place, interest in simulation modeling to solving traditional business problems, including small business applications, dramatically increases. (see Cochran, Richardson, Nixon, 1990) Consequently, utilization of simulation models in DSS for business MCDM will become even more prevalent in the near future.

OTHER SIMULATION ENHANCEMENTS

An interactive debugging expert system for GPSS/H was developed by Mellichamp and Venkatachalam (1990) to reduce the burden on the simulation analyst during model development. Since debugging is often the most frustrating part of simulation model building, this expert system significantly reduces the analysts' effort in identification and correction of model defects.

Rathburn and Weinroth (1991) developed a PC driven simulation using a front-end expert system with OOP characteristics to interface with a generalized problem type model in GPSS/H (not a OOP language). An interactive approach allows the user to easily consider a number of prototypes based on the specific parameters of interest. The objective of this system is to develop a menu of generalized simulation models with associated front-end expert system. The users can be proficient in parameter sensitivity analysis for multi-criteria decisions with no experience in simulation or expert systems.

GRAPHICS AND SIMULATION

The first visually interactive simulation (VIS) discrete event software SEE-WHY appeared on the commercial market in 1981 (Fiddy, E.; Bright, J.G.; and Hurrion, R.D.; 1981). R. D. Hurrion (1986) defined VIS as "Visual Interactive Simulation is one which has features for graphical creation of simulation models, dynamic display of the simulation system and user interaction with the running program. Interaction implies that the simulation halts and requests information from the user, or the user stops the simulation at will and interacts with the running program." Interactive graphics packages have recently been introduced for continuous modeling applications and OOP. As a result of these technological developments and product maturity, there has been a literal explosion in the number of commercial packages, the number of users, and the number of applications of simulation modeling for problem solving.

A survey of builders of visual interactive models (VIM) (Kirkpatrick and Bell, 1989) indicated that this technology has been around long enough to have developed a high degree of technical maturity. This survey was mailed to all known simulation model builders and was also distributed through the software suppliers to their customers. Among numerous survey results, it was generally agreed that simulation models take longer to build than traditional mathematical models but the total time required to solve the problem was much less because of the reduced time needed to discuss the model and its assumptions with the decision makers. In addition, the decision-makers understanding had increased "moderately," "greatly," or "incredibly," relative to the problem options available in 95% of the cases, and relative to the system modeled in 90% of the cases. Also, 60% of the respondents indicated that the problem definition changed significantly as the model progressed and experience was gained with the system being modeled. Most important, 33% and 48% of the respondents indicated that user requests had increased a "little" or "greatly" respectively for building new simulation models because of previous success using graphics with simulation.

SIMULATION IN INDUSTRY

A survey of corporations by Gershefski (1969) indicated that 19.5% had or were developing planning simulation models and a 1975 replication (see Ishikawa and Stein, 1976) indicated a three fold increase to 73%. A more recent survey of Fortune 500 companies indicated that 80% of the respondents were using simulation as an aid in management decision making. (Ford, Bradbard, Cox and Ledbetter, 1987)

A 1983 replication of a longitudinal survey of 250 practitioners and 250 educators in DSS and MCDM indicated that simulation was now the second most important quantitative technique with educators selecting linear programming first and practitioners selecting statistics first. (Harpell, Lane, and Mansour, 1989) These researchers concluded that educators, as providers of "foundations for students," need to utilize the recommendations of the practitioners to expand their coverage of DSS and MCDM to bring the real world (simulation) into the classroom.

Professor Harvey M. Wagner (1988) of University of North Carolina, in his Harold Larnder Memorial Lecture states "computer simulation models have enabled companies to test strategies before implementing them and thereby substantially reducing the risk of adopting an unworkable approach. The ambitious nature of these applications is impressive. Of all the techniques mentioned, simulation is the most resource intensive. Nevertheless, the number of applications of this approach probably exceeds that of mathematical programming by a factor of 10 to 1."

A June, 1991 informal discussion with Thomas M. Cook, president of American Airlines Decision Technologies (AADT) and The Institute of Management Science (TIMS), confirmed that the operations research groups in industry are rapidly implementing simulation modeling in their DSS. AADT has found that simulations with graphics (SIMAN & CINEMA) significantly assist in presenting supporting information to top management for recommended decision approvals.

It is apparent from these findings that simulation is now an integral part of the DSS for MCDM in large and medium size business organizations.

TEACHING SIMULATION IN BUSINESS SCHOOLS

Simulation in general has been taught in undergraduate and graduate schools of Engineering, Biological Sciences, and Computer Science since the early 1970's. (Shub, 1980)(Cellier & Vogel, 1981)(Spain, 1983 & 1984) However, a literature search starting in 1980 found 24 citations relating to teaching simulation techniques in the engineering and science areas and only 2 citations relative to business (B) school instruction. (Curry, Deuermeyer, Feldman, 1988)(Smith, 1989)

In addition, a review of the undergraduate curriculum at Colorado State University, a premier simulation modeling institution (see Simulation, V.51 No.4, Oct. 1988, p: 133), showed 4 simulation courses being taught, none in the college of business. A review of the 1990 curriculum of the 20 top ranked business schools (see Byrne, 1990; Urbancic, 1989) indicated that only 5 had simulation courses offered for undergraduates.

However, it should be noted that undergraduate seniors are often permitted to take graduate simulation classes as an elective. Dr. Edward Russell, a long term simulation practitioner and adjunct faculty member in the graduate business school at University of California, Los Angeles, indicated that his current class is more than 50% undergraduate business operations research majors who received permission to take his graduate simulation class as an elective.

A survey of 51 American Assembly of Collegiate Schools of Business (AACSB) by Gunawardane (1990) relative to their required undergraduate course in Management Science/Quantitative Methods indicated 87.5% included simulation modeling in the course. However, a review of 7 current text books in this field revealed only superficial discussions of simulation with 3 including simulation demonstrations in their personal computer (PC) software packages.

Based on these findings, it was concluded that B schools in general and undergraduate B school programs specifically have been slow to incorporate simulation modeling in their curriculum.

TEACHING BUSINESS DECISION MAKING USING A SIMULATOR

A business decision making simulation course was developed and taught in the business school at Metropolitan State College of Denver during the spring semester of 1991. This course was an outgrowth of the interest in simulation by several of the faculty members in the Computer and Management Science department and the recent availability of new Simulation texts with student software. The objective of the course was to expose undergraduate business students to the use of simulation models in DSS for MCDM.

Language and Text Selection

After surveying five different simulation packages it was decided to use a new text by Tom Schriber (1991) "Introduction to Simulation Using GPSS/H" primarily because the instructor was very familiar with GPSS language and the text came with a student version of the language compiler (computer disk). Also, Schriber provided extensive classroom notes and outlines, transparency masters and student exercises and exams. The text was designed to move the student through progressively more difficult simulation exercises, which not only emphasized specific topics in simulation theory but also progressed through increasingly more difficult manipulations of the GPSS/H language.

Student Course Evaluation

The major draw back of the selected text and language was the significant time required by the students to learn the language and complete the model building and analysis assignments. There was universal agreement by the students that the language was not difficult but required significant time to become proficient in model building. The overall student evaluations of the course were bi-polar (strongly like or strongly dislike) with an overall mean of 4.85 on a one to seven ordinal scale. The major complaint of the strongly dislike students was the necessity of learning another computer language and the significant time commitment necessary to be successful in writing (developing) a correct simulation model. Also, almost all of the students would prefer to find and model their own simulation problem (an outside term project) rather than use the classic cookbook simulation problems utilized in the text.

Instructor Evaluation

From an instructor point of view it was challenging to keep ahead of the students relative to the course material and homework assignments (maintaining competency in a new course). In addition, due to the language syntax, there was not enough time to delve deeply into the theory of simulation, DSS and statistical analysis of output without putting an undue burden on the students interest and conceptual understanding. These is an important aspect of decision making that should not be ignored.

Classroom Conclusions

It was obvious that a Simulator type language would have greatly reduced the language programming problems and the model construct problems encountered with GPSS/H. Also, with reduced time spent on programming, additional time could be spent on the underlying theory of simulation which was somewhat strained. As a result of this experience, the instructor is going to select one of the new Simulators for future courses. In addition it was determined that outside term simulation projects, although very risky, would be helpful in establishing student ownership of the course as well as stimulating interest in utilization of simulation to solve a wide variety of business problems.

SUMMARY

Computer simulation in business DSS has come of age and is the “first choice” method of problem analysis and solution. The development of numerous simulation/graphics language packages and particularly the “no programming” Simulators, has greatly enhanced an individuals ability to use microcomputer simulations for business problem solving and decision making. Practitioners in the problem-modeling field have indicated that simulation is preferred over traditional linear programming techniques. Simulation modeling is no longer the sole domain of graduate programs, engineering schools, or management science and operations research groups and has gained the acceptance and maturity of a universally applicable decision tool.

As institutions of higher education, business schools have the responsibility to be on the “leading edge” of technology applications rather than being satisfied with emulating current business practices. Simulation models are essential for all businesses DSS of the future.

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