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ENHANCING MAINFRAME SIMULATIONS VIA MICROCOMPUTERS: DESIGNING DECISION SUPPORT SYSTEMS

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ABSTRACT

Given the proliferation of business workstation microcomputers for managers, the authors discuss the need for familiarizing students with the use of decision support systems (DSS) to make business decisions. In addition, combining a DSS with the mainframe business simulation is suggested to enhance the pedagogical effectiveness of the simulation method. The authors describe a current application of this approach whereby continual simulation play across semesters affords each team a unique starting point and generates a rich history base. Teams are required to learn and use Lotus 1-2-3 as a custom-made DSS to analyze the history file and develop their marketing strategy. This approach affords the benefits of realism, relevance, computer literacy, flexibility, and opportunity for refinement. Suggestions for future simulation enhancements include providing teams with the ability to decide when to make decisions and the addition of an expert system as a strategic advisor.

INTRODUCTION

The appearance of desktop microcomputers in business and educational environments has been a rapid and pervasive occurrence since the introduction of the microcomputer in 1978. Business decision makers are relying more heavily upon the spreadsheet analysis capability provided by software packages such as Lotus 1-2-3 or Symphony. Academicians are increasingly using statistical applications packages to assist in their quantitative analysis needs. Even though microcomputers have only been available in the marketplace for eight years, their impact on the nature of decision making tasks in business and academia is clear.

Recent advances in software are exerting even more pressure for change in decision making styles. Available programs such as Symphony or Appleworks offer integrated packages, allowing word processing, spreadsheet analysis, and even graphic design tasks to be combined into the same work session. The integrated software package moves the business executive closer to the ideal role of an active decision maker backed up by immediate access through his microcomputer to comprehensive and relevant information about company activities. This new perspective on a decision maker's role means that the executive must take a much more active role in deciding what type and how much information is needed and how that data is best presented to facilitate the required decision. This role requires a manager who is knowledgeable about the benefits and limitations of decision support systems.

In this paper, we will adopt the definition of a decision support system (DSS) provided by Schellenberger (6), who describes it as "a computer-based, data-based system for aiding in decision making, especially decisions where a combination of quantitative and executive judgment is involved". In the past, these decision support systems have tended to be idiosyncratic to the sponsoring

organization and primarily mainframe based, since that was also where the data resided. The proliferation of microcomputers and DSS-useful software in the business sector provides the ability to design decision support systems via the microcomputer for the managers' particular application. This situation presents a significant challenge to those educating prospective managers. Educators must strive to integrate microcomputer systems and decision support system design into the set of decision making skills imparted to business students. Further, as microcomputer DSSs are increasingly relied upon in the business sector, it is imperative that we develop students with decision making skills which are faithful to the business environment.

Business and academia have both used mainframe computer simulations to represent realistic business phenomena for training and decision making purposes. As the use of simulations has evolved in business environments, DSS enhancements have typically been added. Klein, as cited in Muhs and Callen (5), reported that 85% of the largest U.S. firms utilized financial modeling, most commonly geared to "what-if" analysis. While these models tend to be firm-specific, the typical manager does have a workstation PC and spreadsheet and data base management software to analyze performance information. Thus, knowledge about the design and use of DSS should increase the efficiency of business decision makers.

Academics use of the mainframe business simulation to teach decision making skills to students has been pervasive. Currently, virtually all business students in major state universities as well as students at other schools are exposed to computerized simulation exercises during their academic careers. However, the adoption of DSS for these simulations has not seen the same rate of adoption experienced in the business sector, as noted by Lil, Shannon, and Peterson (4). Students are being exposed to general decision making situations without benefit of the DSS tools that would be commonly available to them in the business world. The purpose of this paper is to: a) discuss the development of DSS for mainframe business simulations, b) describe the form of a DSS for a simulation already in use at the authors' university, and c) speculate on future possible enhancements for simulations and DSS.

DEVELOPMENT OF DSS IN BUSINESS EDUCATION

A review of the literature on DSS reveals three basic approaches to development. The distinction between these approaches depends on which machine- the mainframe or the microcomputer- is used to operate the simulation and which machine is used to host the DSS. The first approach is to rely totally upon the mainframe for both simulation operation and DSS analysis. This option is exemplified by Muhs and Callen (5), who have developed a program utilizing a mainframe DSS called the "Interactive Financial Planning System" (IFPS) in conjunction with the mainframe simulation IMAGINIT. The IFPS allows students to generate simulation data-base information

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Another approach to developing DSS is to design a totally microcomputer based simulation and DSS. For example, Whitney (7) has reviewed two such programs Cartels and Cutthroats" and Free Enterprise. Whitney correctly points out that these simulations are appropriate for smaller colleges without full mainframe availability. Under these circumstances, simulation operation and DSS analysis are limited by the memory capacity of available microcomputers. Such limitations make this DSS design approach unsuitable for large scale simulations incorporating many variables in an attempt to be more realistic.

The final perspective which has been used in developing DSS is a hybrid approach. The mainframe is used to host the simulation while the microcomputer is used to operate the DSS. Dolich (2) describes how he uses the MARKSTRAT simulation game, coupled with a series of microcomputer spreadsheet/graphic analysis programs under the trade name, MARKSTRAT Applications. The students enters the database available from the mainframe simulation results and may select from a menu of twelve performance measures such as demand forecasts, profit and variance analysis, or market segment penetration.

DSS Environmental Characteristics

The third approach to DSS design provides the most realistic match with the DSS environment faced by most business decision makers. Performance data for the firm is typically available on a mainframe computer which the manager may access through a workstation terminal or microcomputer. This historical data base may then be examined via commercially available software (e.g., Symphony, Lotus 1-2-3, Appleworks, etc.) for trends and other evidence of successful strategies in particular market environments. Before such analysis can take place the manager must design the DSS which will collect and present the data in a form that is relevant and effective for his decision making. Managers have typically relied on their staff personnel or the organizations marketing information system for such tasks. In effect, these people were the managers DSS. With the microcomputer, it is more efficient for the manager to perform these tasks. The executive must decide: a) what information is needed for the decision, b) the level of detail needed in the information, c) what form the information should take, and d) where the information is to be found. The package described in this paper attempts to model as closely as possible the DSS environment faced by managers; that is, a mainframe-resident historical data base which may be accessed via a workstation machine. This arrangement necessitates the design of a DSS prior to information analysis or decision making.

COMBINING THE MAINFRAME SIMULATION AND MICRO-BASED DSS

The combination of the mainframe simulation and microcomputer DSS can be used to provide a high degree of realism while enhancing the pedagogical effectiveness of the traditional simulation approach. The package described in this paper offers the following departures from traditional simulation methods: a) a historical data base from past simulation periods is available for analysts, b) student teams are required to design their own DSS before they can begin making simulation decisions, c) unequal team starting positions provide the opportunity to use a wide range of marketing strategies and increase team motivation to analyze the history data base.

A characteristics of most mainframe simulations is the "black box" factor. That is, there is an intentional lack of accurate knowledge about the success parameters of the simulation. This situation is intended to provide realism to the simulation experience as students will "discover" certain regularities and generalize them into basic strategic principles. However, if students have no model of expert or proper behavior to observe, learning may be impeded, as documented by previous research results on the effectiveness of simulations such as Cross, Foxman, and Sherrell (1). In the business world, there are clear winners who serve as expert player role models as well as losers whose plights are common knowledge. Further, there is ample opportunity to study either or both sets of histories in a business DSS setting. Consequently, it is more realistic to provide the opportunity for current student teams to study past simulation results to gain at least a partial understanding of which strategies did or did not work in the past for given environments.

Apart from realism, there are other reasons supporting across-semester industry simulation and the creation of attendant historical data bases. Student teams typically spend a large portion of their time attempting to ascertain what their competition is up to. Some portion of this competitor analysis is an attempt to recognize and predict patterns portending specific marketing strategies. The typical simulation starts all teams from the same market share position with equal company resources. In order for teams to pick out a pattern of decision tactics indicating a specific competitive strategy, a sufficient history of these decisions must occur. However, in the typical simulation a sufficient history of such decisions will not be established until somewhere in the middle of the simulation. Thus, a competitor monitoring approach in an equal starting points simulation offers little in the way of diagnostics for assessing relative company performance in the early stages of the simulation.

Our solution to this problem is to provide historical data on past teams experiences with the simulation. Part of the output of each simulation decision period is a history file containing company data to be used in calculating the next periods results. By keeping these history files after the simulation period is over, a historical data base may be accumulated over several semesters. Thus, in much the same way as the PIMS data base may be used to analyze the effects of particular strategies, students can analyze past decisions and recognize patterns which were obviously successful for given environments.

DSS Design Requirements

The availability of a simulation history data base also provides the opportunity to require teams to think about the type and amount of information required from the data base prior to making initial simulation decisions. This feature is operationalized by providing information to teams to help them make their first simulation decision. The information is intentionally incomplete and teams must identify the relevant missing information to be able to request it from the simulation administrator prior to the first decision. At the same time, teams must design an information analysis program (i.e., DSS) via spreadsheet software which allows them to access and analyze the history data base. Thus, teams are forced to think about what their decision information needs

are and how to acquire, analyze and present the data before they make their initial simulation decision.

Unequal Team Starting Points

The use of unequal starting points in a business simulation provides an opportunity to increase the realism of the exercise and enhance the usefulness of the history data base for finding trends in decision and performance histories. Unequal starting points force teams to employ a wider range of marketing strategies to improve their companies position. While equal market positions and company resources provide similar chances for "success", few teams will choose to consolidate operations and concentrate on a limited subset of available markets without substantial urging from the simulation administrator. The tendency for most teams is to grow as fast as possible with respect to market share or profitability. This tendency is easily avoided if the mainframe simulation is carried over from semester to semester with each new team picking up where the previous semesters team ended.

The unequal starting position increases both the relevance of the DSS design task and team motivation to analyze the history data base. The previous decision and performance history of a firm becomes much more relevant to a team if they inherit that firms resources and market position rather than receiving the same status and resources as all other firms in the industry. The enhanced usefulness of the history data base also increases the teams motivation to design an effective DSS with which to analyze the historical information.

Description of Mainframe Simulation

The marketing simulation used with our DSS is Compete by Faria, Nulsen, and Roussos (3) and is currently in use by a senior level marketing class at the authors university. Compete allocates demand according to the relative advantage a firm has over its competition, not according to some pre-determined criteria. The simulation requires decisions to be made in four main marketing decision areas, allowing formulation of a complete marketing strategy by the student team.

Students are organized into five teams within an industry. Each team may elect to sell any or all of three electronic products in any or all of three market regions. These products may be introduced or dropped any time during the simulation. For each decision period, the team must:

- a). supply prices for each product/market combination.
- b). determine optimum production levels to meet forecasted demand.
- c). hire and allocate enough salesmen in each region to distribute the products.
- d). determine the advertising budget and allocation across products, market regions, media, and message content.
- e). allocate sufficient research and development monies between cost reduction efforts and product quality enhancements.

Each decision is evaluated relative to competing firms decisions. Firms are able to purchase marketing research information about their competition and the industry in order to obtain an accurate assessment of the situation. Student teams are provided with complete financial feedback in the form of balance sheets and income

statements. Also, information on market share, inventory levels, earnings per share and several other activity level indicators are provided.

Simulation and DSS Administration

With use of Lotus 1-2-3, several history files are maintained for each firm in each industry. Figure 1 details the several decision and performance variables which are retained for each firm for each quarter. At the onset of the semester, teams are formed and randomly assigned to firms and industries. Each team is provided with an orientation to Lotus 1-2-3. In addition, each team is provided documentation of the file names and variables contained in the simulation history data base. The host Lotus 1-2-3 disk is preprogrammed with averages and various aggregations for the decision and performance variables across the industry. The files allow perusal and/or printout of variables in spreadsheet form. In addition, a graphics option allows a team to see the changes of decision variables plotted against performance measures (e.g., E.P.S) for their company or any other firm in the industry. Figure 2 is a representative example.

Just as an executive with a workstation PC experiments with his data base, each team is required to devise and program its own measures of effectiveness and efficiency. Each team is provided an initial template which uses period expenses and generates percentage breakdowns. Additional efficiency and effectiveness measures are discussed in class, and teams are informed that a component of the final simulation grade will be taken up by the effectiveness and efficiency measures they select and program into their template. Finally, forecasting methods are covered along with "what-if" scenario analysis. Students are instructed to integrate these into their templates as well. In short, each team is required to determine, program, and interpret spreadsheet analyses both before and during the simulation.

Prior to beginning the simulation, students are instructed to treat the history files as a raw data base which holds the potential of revealing regularities of relationships between decision variables and performance outcomes under various competitive situations. The history data base has some information necessary to make the initial simulation decision intentionally deleted from it. Students are also told that an "internal consultant" (i.e., a graduate student familiar with last semesters game results) is available to answer any questions they might have after they evaluate the historical data. The students then should eventually realize that certain key data is missing from their information set, such as ending inventory, salesforce size, sales commission rate, etc. The "internal consultant" can provide these figures, but only if the student teams realize they require it. Essentially, this exercise requires the student teams to match their simulation decision variables with the information provided by their decision support system to determine where information voids existed.

Once teams have had an opportunity to study the data files, actual play commences. Each team begins with the ending position and resources of the firm in the previous semester. Objectives and strategies are idiosyncratic to each teams situation from the initial decision. As decision periods pass, each team maintains its own proprietary history files containing its decisions and performance. During the course of the semester, this data set serves as a growing data base for each company, and diagnostic analyses are applied to attune marketing strategy hypotheses to the present competitive environment.

Benefits of the Mainframe Simulation/Micro DSS

At this point, the authors have not addressed the effects of this approach with an empirical study. Consequently, the benefits must be presented as observations. We believe at least five specific benefits accrue from our approach:

- 1). Realism- Use of a sequential, unequal positions start is much more realistic than is a partitioned, equal-positions start. Just as an executive joining a new company will not be faced with equal competition, teams find themselves challenged with uneven market shares and resources.
- 2). Relevancy- The executive at his workstation microcomputer is on the verge of being the norm. Thus, a pedagogy which allows students to role play with hardware, software, and a data base with reasonable approximation to what they will soon encounter as managers is certainly salient.
- 3). Literacy- The specter of microcomputer literacy looms large for students in professional schools. While most secondary education now requires microcomputer familiarity, many college students have a low experience base with them. Consequently, the orientation to microcomputer and spreadsheet analysis is a necessary part of their education.
- 4). Flexibility- Compared to other DSS options, the present approach is the most flexible. The mainframe-bound DSS is cumbersome and unnecessarily expensive; the micro-bound DSS is simplistic and simulation-specific; but the mainframe-micro option applies the mainframes power to generate data and the micros convenience to host the DSS. Once data is captured on file, the spreadsheet analysis alternatives are almost unlimited.
- 5). Opportunity for Refinement- The present approach has the disadvantage of necessitating item-by-item entry from decision sheets or financial reports. Students are responsible for their own companies records; however, as might be expected, the data is not always entered promptly or with perfect accuracy. We are considering a further refinement where data will be downloaded directly from the mainframe files to microcomputer memory or diskette. Hopefully, this direct link will resolve the difficulty and accuracy shortcomings.

SUGGESTIONS FOR FUTURE SIMULATION ENHANCEMENTS

Two ideas for enhancing the effectiveness of current business simulations are offered. The first suggestion deals with altering the typical decision making environment of simulation teams, while the second idea concerns the addition of an expert system to the DSS constructed by the simulation team.

Typical mainframe simulations suffer from a lack of realism in the administration of team decision inputs. All team decisions are usually input simultaneously, implicitly assuming that all industry firms decisions exert their influence on the market simultaneously. Obviously, business firms may choose when to react to current market conditions. Most simulations lack this decision timing aspect in their design. A more realistic decision process

would be to allow team

decision inputs on a random basis within a specified time period (e.g., one week, two weeks, a month, etc.). When coupled with a DSS which supplies current market information about the simulation, such timing decisions would add greatly to the realism of the simulation.

A constraint to random decision making is that in order to preserve the dynamic aspect of the simulation (i.e., evaluating the effectiveness of a firm's decision relative to all other firm's decisions), a demand model capable of updating its parameters based on current decision inputs must be developed. In this way, the decision of a firm would be evaluated against the market situation as influenced by competitors' most current decisions. It would seem that simplistic demand models could be developed for simulation purposes. The difficulty lies in how the demand model would be updated based on various firm's decisions.

A second area of development for simulation-DSS combinations is the addition of a simulation-specific expert system or advisor. This program would contain knowledge about the success parameters of the simulation, specifically what marketing strategies would most likely be successful given various market conditions. The expert system program design would be in the form of if-then rules such as "if current market share is equal to or greater than industry average and current earnings per share is greater than industry average, increase price (or advertising). Such rules could be built up to cover most circumstances faced in the limited simulation environment. The simulation administrator would provide the expert system to teams prior to the start of the simulation, when teams are analyzing the historical data base.

The purpose of such an expert system would be to enhance the learning effectiveness of the simulation method. Since the expert system has the rules for its strategy suggestions stored internally, teams could provide the expert system with information from their DSS, ask for strategy suggestions, and then query the expert system for the reasons behind the solution choice. The system would then simply list the applicable set of if-then rules governing the solution.

Expert systems are attempts to use the computer to solve specific, well defined problems with accuracy comparable to humans. The business simulation is an excellent example of such a constrained problem space. The use of such a system together with the team DSS and mainframe simulations should serve to enhance student learning greatly.

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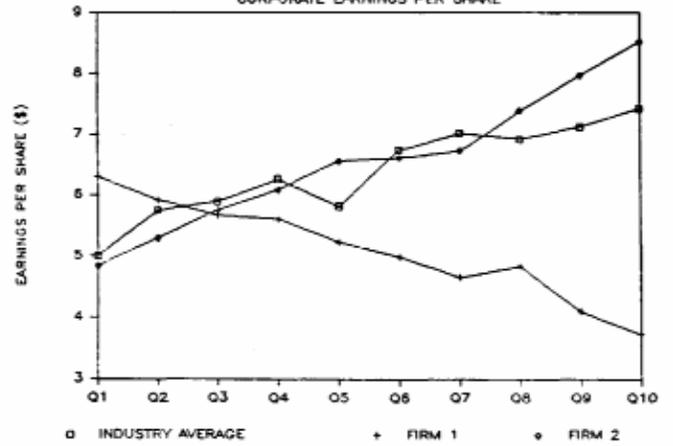
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FIGURE 1

PRODUCT DECISION AND PERFORMANCE VARIABLES ON HISTORY FILE

- 1. ADVERTISING AS A PERCENT OF SALES
- 2. INDUSTRY AVERAGE ADVERTISING AS A PERCENT OF SALES
- 3. RESEARCH AND DEVELOPMENT EXPENDITURES AS A PERCENT OF SALES
- 4. INDUSTRY AVERAGE R&D AS A PERCENTAGE OF SALES
- 5. PRODUCT PRICE (3 PRODUCTS)
- 6. INDUSTRY AVERAGE PRICES
- 7. CORPORATE REVENUES
- 8. CORPORATE EARNINGS PER SHARE
- 9. MARKET SHARE BY PRODUCT

FIGURE TWO
CORPORATE EARNINGS PER SHARE



ADVERTISING EXPENSES

