

Developments in Business Simulation & Experiential Exercises, Volume 14, 1987

THE USE OF EXPERT SYSTEMS TO DEVELOP STRATEGIC SCENARIOS: AN EXPERIMENT USING A SIMULATED MARKET ENVIRONMENT

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ABSTRACT

An experiment is proposed that will constitute an initial step in building a comprehensive expert system model that will simulate strategic scenarios of use in the evaluation of policy and strategic circumstances affecting the contemporary organization. Construction of the expert system model will proceed over several stages. Making use of historical data and specific decision rules, the system will attempt to describe the group decision making with a management game played in conjunction with an undergraduate management course. It is expected that the findings of this experiment will provide a preliminary understanding of the methods by which an expert system develops strategies. The experiment will contribute to the growing interest by the business community in the applicability of expert systems to business decision making.

INTRODUCTION

This paper will discuss an experiment to evaluate the use of an expert system in strategic decision making applications. The experiment is extremely limited in scope and is a first step to building a comprehensive expert system model. The intent of the model under development is to provide an experimental environment to test the use of expert systems as a tool to help decision makers in evaluating policy and strategy circumstances facing the organization. Then the model will provide alternatives to consider in evolving strategies to meet environmental and organizational issues.

The paper will explore the issues of group decision making that are frequently encountered in the development of strategic alternatives. Then, the issues of expert systems and their relevance to strategy development and policy implementation will be discussed. Finally, the details of the expert system model and the artificial intelligence experiment will be examined.

GROUP DECISION MAKING

Decision making is as fundamental to the human experience as it is complex. Effective decision making draws from a wide knowledge base and a host of planning behaviors. As a cognitive activity, it is psychological in nature and can be conducted either by an individual or through a group process. Artificial intelligence, through the development of expert systems, has recently begun to play a crucial part in the decision making process. [8]

In his summary of the research opportunities in the decision and management sciences, Little [7], highlighted the importance of understanding decision making over time, understanding expert judgement and understanding group decision making among people in real organizations. Responding to Little's stated need for research in decision making requires a combined knowledge of group decision making and expert systems.

In the research proposed herein, the authors will attempt to develop and assess the reactions of an expert system to a group decision making process. Central to this interest will be the effect on the expert system of a stochastic decision making environment.

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

The field of artificial intelligence evolved as a result of a dual interest in making computer processes more intuitive and in understanding intelligent behavior. Its real origins, as currently applied, date from the Late 1940's with the development of cybernetics and the goal of developing a series of simple theories to explain the activities of the human mind. Early efforts in the direction of developing general principles of problem solving led to the

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conclusion that without advances in theory of computer program design, artificial intelligence efforts to model the heuristics of general problem solving were not likely to be as productive as the application of computerized problem solving techniques to domain specific problems.

Artificial intelligence research has taken a number of different tracts, but one of the most far ranging has concerned the development of programs for solving problems that are difficult enough to require specific knowledge and human expertise. These programs, called "expert systems" or "knowledge systems", refer to computer systems that have evolved from research in the field of artificial intelligence. These computer programs behave in a manner similar to a human expert, and are designed to represent and apply factual knowledge of specific areas of expertise to solve problems. [10]

The components of an expert system can be divided into three sections: a knowledge base, an inference mechanism, and a fact data base, [5]. Working in a specific task domain, an expert system gains power by having a large amount of knowledge and uses an automated inference process to draw conclusions from that knowledge. The knowledge base consists of information collected from the expert system user, information inferred by the expert system, and any of the detailed information pertaining to a specific task.

Research efforts in the area of expert systems have resulted in the development of computer programs that provide the user with a context for specifying different courses of action. The user is able to project a scenario beginning from that action, and is able to estimate the likely consequences of that action.

Blanning [1] contends that successes encountered by researchers in developing expert systems in decision-making areas such as game playing, medical diagnosis, chemical structure analysis, geological exploration, computer configuration solution and computer fault diagnosis has given rise to the possibility that expert systems can be developed for managers to capture their specialized decision tasks. An expert system for managers would diagnose potential or actual problems, recommend strategies and offer, on demand explanations for their diagnosis and recommendations.

PROPOSED RESEARCH EFFORT

Current attempts to develop artificial intelligence applications are much broader and more intensive than at any time in the past. No one expects this interest to revert to its previous status, as an academic curiosity. In keeping with Reitman's [9] view of the developmental progression of artificial intelligence from initial conceptual analysis stages to commercial

applications, there is growing interest by the business community in the applicability of expert systems to business problem solving and decision making. [11]

Of the many existing expert systems of diagnostic decision making, few models have been developed that simulate group decision making over time. Is the group decision making process different from individual decision making? Can an expert system be developed to simulate the group decision making process? What are the common types of decisions faced by group decision makers? The objective of the proposed research effort is to provide some of this knowledge. Its focus will be the development of an expert system that will attempt to simulate group decision making over time.

In searching for an environment to provide an adequate test of an expert system designed to monitor and develop strategic alternatives, the research team decided to employ the management game as an experimental setting. This setting offered the opportunity to test the expert system model in a real stochastic decision making environment while at the same time having some control over the limits of the experimental domain. A description of the management game being used in the artificial intelligence experiment is contained in the next section of this paper.

The general method that the experiment will follow is described below

- * Develop a set of decision rules for the expert system based on testimony of expert users of the management game. The Management Department faculty provided the expertise necessary for developing the decision rules. The development method used to build the rule set was a modified Delphi technique.
- * Build a knowledge base from historical data collected from past iterations of the selected management game.
- * Develop the expert system using the rules and the knowledge base discussed above and using an expert system software shell called Expert Ease. This is a PC based expert system shell.
- * After the model is built, it will be tested using a set of data from a recently completed game iteration. This test will be implemented by taking the results of a recent game, replacing one of the teams that participated in the game with the expert system and rerunning the game period-by-period. The experiment will

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use real world decisions previously made by participating student teams and the new decisions developed by the expert model.

- * Compare results obtained when the game was played by all student teams with the results obtained when one student team is replaced by the expert model.
- * Tune the expert system model based on experimental performance evaluation. Play the game again with another completed iteration and with the expert model replacing one student team. Again, evaluate experimental performance and fine tune the expert system model.
- * Finally, use the expert system in an actual game iteration where the system will be competing against live student teams. Use the game in competition for twelve actual competitive cycles.

Game Description

The task domain that will be used for the strategic decision making experiment will be the strategy planning and decision making component of a competitive business game ongoing for a sequence of time periods. Here, at Pace University, the Business Strategy and Policy Game [4] has been used for a number of years in the Business Policy course. The BUSPOG is a management exercise involving three levels of managerial activities functional (marketing, production, personnel and finance); coordinative and organizational.

The BUSPOG deals with a hypothetical refrigeration industry made up of as many as seven companies that compete within three markets. The management team of each company makes a set of decisions for each quarter of the year. The particular decisions involved might include selling price, product research and development, scheduled production work week, raw materials ordered, profit sharing and dividends. See figure 1 at the end of the text for the actual list of the decisions teams made each quarter.

The team decisions are processed through the game computer program. The results of the competition for the quarter are reported to each company in the form of computer printed outputs. These results depend not only on a management team's internal decisions but also on the external environment which includes the company's customers, competitors and the economic situation.

The BUSPOG computer program incorporates a number of hypothetical relationships. These relationships represent a conceptualization view of how such an industry and its environment might

behave. In the real world, the forms of some relationships are known with a degree of certainty while those of others are only vaguely known. This is also the situation in the game. The game's economic environment is determined by six variables : GNP, personal consumption, expenditures for durable goods, number of household formations, bond interest rate, loan interest rate and raw material cost. The competitive environment is determined by the interaction of the decision makers on each team.

Data has been collected over a five year period relevant to the decisions groups have made while playing the game. This data will be used to develop the knowledge base for the expert system model. The University's Management Department faculty, acting as the knowledge source, was given a set of 30 possible variables and relationships that influence the decisions made while "playing" the game. They rated the importance of the variables and listed the factors affecting these variables and the likelihood of relationships to the strategy necessary to compete in the game. Faculty responses were evaluated and recirculated using a modified Delphi technique. From this process, the model development team evolved a set of game specific decision rules which will be incorporated into the expert system model.

After the expert system model is fine tuned using several controlled experimental runs, it will become one of the group decision makers competing with student groups in an actual industry. The student groups will not be told they are competing against an expert system model.

The expert system model is being written for a microcomputer using an expert shell called EXPERT EASE by Human Edge Software Corporation . EXPERT EASE can handle up to a maximum of 31 decision variables that can be assigned a maximum of 32 values. Figure 2 at the end of the text shows a brief example of a decision model built with the EXPERT EASE software shell.

Expert System Model

Strategy is the pattern of decisions in a company that 1) shapes and reveals its objectives, purposes, or goals; 2) produces the principal policies and plans for achieving these goals; and 3) defines the business the company intends to be in and the kind of economic and human organization it wants to be [3]. The management game provides the means for studying decision making in the broad strategic sense within a controlled experiment . The research design will allow the development team to study the method by which expert systems develop strategies. More importantly, the effectiveness of the decision can be tested in a simulated environment within a realistic time period. Inferences can be drawn regarding the longitudinal impact of strategic scenarios in a collapsed time frame.

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In designing the expert system model the research team evaluated the decision rules and data available and then attempted to set up a model which could best respond to the demands of a management team faced with the problems inherent in the game's industry environment. Experience has indicated that there are three basic strategies that work best in the game's simulated market place. These strategies are

- * High Volume-Low Price This approach seeks high volume sales coupled with low cost production. In turn, this low cost will enable the company to set a lower selling price resulting in raising market share. Margins are usually small.
- * Product Differentiation: This approach will entail the production of a differentiated product that will culminate in the attainment of a steady market share while achieving a high profit margin. The firm benefits by reducing the impact of price competition.
- * Reactionary: This approach is followed by the company that is no longer capable of a leadership position in the market. The firm can not maintain a highly competitive stance. This strategy usually is the result of a lack of financial resources.

With the above as a background, the expert system development has started. The model is to be constructed in three parts. These are

1. The Analysis Section . Its function will be to analyze the current operating quarter's results. To compare these results with historical data and to apply the decision rules. Based on this analysis ,the model will decide whether to continue with the current strategy or to switch to a different strategic scenario.

2. Strategy Development and Implementation. The section of the expert system is made up of three distinct substructures :a) high volume-low price procedures, b) product differentiation procedures and c) reactionary procedures. The analysis subsection will route the process through the appropriate decision making algorithm. The selected set of procedures will develop the expert system decisions that will implement the model's selected strategy.

3. The reporting segment. This model section will report the developed decision list formatted for direct input to the management game. There will also be reports detailing the status of the expert system. Of particular interest will be information on recently evolved decision rules, modification of existing decision rules and explanations of the process followed

in maintaining or changing basic strategies. Figure 3 at the end of the text shows a diagram of the proposed expert system model.

Research Questions

The research effort will attempt to describe the group decision making process over time through an operationally defined model. The decision making expert model will endeavor to follow Bouwman's human-like " approach. The model will simulate the behavior of group decision making while engaged in management gaming.

The research questions to be studied are

- * How will the expert system react to the stochastically changing environment of the management game?
- * How will and to what extent will the expert system modify the decision rules?
- * As the expert system simulates the game over time, will it in the long run develop the game algorithm or its decision making model?
- * How will the expert system perform relative to student actors in the same competitive arena?

Obviously, no single study can fully examine all these components. This research will attempt to gain some insight into these processes and to present an operational basis for further research.

SUMMARY

In this paper, the researchers have described an experiment that is being conducted at Pace University to test the use of a knowledge based expert system for the development of strategic scenarios. The experiment described will be conducted through the use of a management game that is implemented in conjunction with the Business Policy and Strategy capstone course in the undergraduate program. The main thrust of the experiment is to evaluate the use of expert systems in a strategic decision making environment. Also, the experiment will test the use of artificial intelligence techniques as a method to assist in a group decision making event.

By the time this paper is presented, it is expected that some experimental results will be available. At a minimum, the expert system model will have been completed and tested with historical data. Results from actual experiments will be presented and discussed at the conference.

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FIGURE 1
LIST OF DECISIONS TO BE MADE BY
TEAMS PARTICIPATING IN THE
BUSPOG MANAGEMENT GAME

Management Decisions

The simulated competition of BUSPOG requires that the management team for each company make a set of decisions once for each quarter of a year. The particular decisions involved include these:

Marketing

1. Selling price for each of the three markets
2. Advertising budget for each of the three markets
3. Salespersons hired or discharged in each of the three markets
4. Product research and development budget for the company
5. Sales commission for the company

Production

1. Scheduled production work week for the company
2. Change in the production labor force for the company
3. Allocation of finished product to the three markets
4. Process research and development budget for the company
5. Raw materials ordered for the company

Personnel

1. Sales salaries for the company
2. Sales training budget for the company
3. Production wage rate for the company
4. Production training budget for the company
5. Profit sharing for the company

Finance

1. Bonds sold or redeemed for the company
2. Bank loan requested for the company
3. Dividends paid by the company
4. Stock issued by the company
5. Savings account deposit or withdrawal for the company

FIGURE 2
EXAMPLE OF THE USE OF EXPERT EASE TO EVOLVE A SIMPLE DECISION

EXPERT - EASE Illustration of a simple program

Problem : To make a decision for an appropriate gift

<u>Money</u>	<u>Age</u>	<u>Gender</u>	<u>Gift</u>
little	adult	*	calculator
much	adult	*	mind prober
little	child	male	transformer
little	child	female	doll
much	child	*	computer

The structure of the rules follows a decision tree. Two rules for this simple system are as follows :

- * If there is little money and the age is child and the gender is female, the gift is a doll.
- * If there is much money and the age is adult, the gift is a calculator.

FIGURE 3
A DIAGRAM OF THE SYSTEM FLOW FOR THE EXPERT EASE DECISION MAKING MODEL

