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SIMULATING THE SIMULATION FOR ENHANCED PLAYER RATIONALITY

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ABSTRACT

An interactive online rime-sharing sharing computer simulation of a simulation game model enables players to perform *what* if" trials of alternative decisions prior to finalizing their decisions for official play of the game. Players may also experiment with "what if" market decisions of competitors. Thus by providing detailed estimated consequences of several alternatives under hypothesized states of market uncontrollables, the rational basis for player decisions is enhanced. AT CR1 terminals players may simulate the next official decision as often as desired and may simulate several periods ahead. At printing terminals they may obtain a printed copy of their decision explorations for later reference.

INTRODUCTION

Interaction by players of simulation games with the simulation model usually occurs only after player decisions are made and the model has generated the consequences of those decisions. Players then make subsequent decisions based on these consequences and the cycle continues for duration of play. Learning occurs as players experience the dynamics of the sequence of decisions and consequences.

If the model is simple enough, given a few assumptions about uncertain environments and, for competitive simulations, about the decisions of others, players can compute hypothetical consequences themselves as part of their decision making deliberations. For business simulations we frequently hear of pro forma financial statements and predictions of such variables as market share and inventory balances. In a sense, these are "thought experiments" or pencil-and-paper trials of potential decisions. However, if the simulation model is complex, or players are pressed for time, proforma statements and computation of potential consequences of alternative decisions may degenerate to quick judgments or even guesses. All that players may have to work with under this pressure is a little game history, a few past decisions, the game description, and whatever knowledge they may have of the system the game model represents.

What if" Analysis

Professional disciplines dedicated to bringing science to bear on the practical affairs of business and government have developed methods based on model building and experimentation to assist decision makers in evaluating alternative courses of action. These activities go by such names as operations research, management science, and systems analysts. The principal function of persons doing this work, which could be more generally called decision analysis, is to evaluate the merits of alternatives available to a decision maker or decision making body. Sometimes decision analysts also work at discovering new alternatives. Essential to evaluating controllable alternative courses of action is identification and prediction of those aspects of the decision situations that are uncontrollable and that may affect outcomes. Decision analysts repeatedly try to answer the question, "What would happen 1) if the decision maker chose particular actions among his controllables, and 2) if those impinging things that are uncontrollable occurred in a particular way?"

Useful answers to this question require a great deal of knowledge about the relationships between the controllables and the uncontrollables. For complex real decision situations with many dimensions of both controllables and uncontrollables, such decision analysis work requires many highly trained persons, large budgets, plenty of time, and computer assistance. Since experiments on the real system are usually too risky, too expensive or impossible, the strategy of decision analysts is to build a model of the situation and perform "what if" experiments on the model. The models are intended to represent the real decision situation. They may be physical (e.g., test model aircraft in wind tunnels), mathematical (e.g., economic lot size formulae), algorithmic (e.g., linear programming), or symbolic and computational (e.g., Monte Carlo simulation of chance processes). A very popular decision modeling technique is computer simulation, with or without Monte Carlo representation of uncontrollables. Computer simulation enables the decision analyst to represent complex interactions among controllables and uncontrollables and to explore the consequences as predicted by his computer model of many hypothetical "what if" questions.

A computer-based simulation game model does not do this. It takes a given set of controllables (from the point of view of one player or player team) and a given set of uncontrollables (the decisions of others and values for certain environmental factors) and computes one (and only one!) set of consequences. But what if "what if" analysis were available to simulation game players?

What if" Simulation of Game Decisions

Competitive simulation game play provides opportunities for three kinds of learning. One is reinforcement of past learning in an applied setting; a second is learning of new concepts built into the game model; and the third is understanding the interaction of all the parts of the system represented by the simulation, including the behavior of other players. With what if" simulation of game decisions, players may ask and get answers to these questions: "What if our team did thus-and-so last decision?" "What if competitors did thus-and-so last decision?" "What if we do thus-and-so this decision, and competitors do not change? "What if we do thus-and-so this decision and competitors change to thus-and-so'" What if any of these combinations is carried on for several decisions?" "What if any of these combinations is made for the next decision and thus-and-so adaptive changes are made by ourselves or others?

Even for simple models, answers to all these "what if" combinations would be difficult to generate in the time usually allocated to decisions, yet such answers--the potential consequences of alterative decisions--are the essence of rational decision making. Irrationality

is to make decisions without considering available alternatives and their potential consequences. The implication is that by forcing players to make simulation game decisions without adequate time for analysis may in fact be training them to be irrational, or at best uninformed guessers.

Using a Simulation Game Model as a Decision Analysis Simulation model

If decision analysis models allow repeated trials of different "what if" possibilities and simulation game models produce outputs after the fact from only one possibility (the actual or official decisions chosen by players), a simulation game model can become an analytical tool if players could use it repeatedly in a trial mode before they must finalize their "official" game decision. This "unofficial" use of a game model differs from pre-play practice decisions in that decision analysis would be available decision after decision for the then prevailing competitive and environmental situation during the entire game play.

As many game administrators have learned, implementing a computer-based simulation game requires much more initial effort and subsequent vigilance than expected. Few perhaps would care to multiply this effort many fold to give players the means to make several trial decisions before each official decision. If players were allowed to explore "what if" values for uncontrollables, particularly the decisions of competing players or teams, as well as "what if variations for their own controllables, then a separate computer model run would be required for each of the many possible "what if combinations each player team may think of. Multiply this by the number of teams and a very large number of computer runs requiring all necessary administrative services could easily be desired by players. Compare this with an official decision when only one computer run is required to service all players.

Thus, a way that removes the administrative time and effort barrier to multiple trial computer runs would also enable "what if" decision analysis and thereby enhance the rationality of game play.

LIMITED SIMULATION OF THE SIMULATION

This paper reports the results of developing and implementing an interactive online time-sharing computer simulation of a simulation game model. The simulation game model was THE IMAGINIT MANAGEMENT GAME [1] which provides output in the form of an income statement, a balance sheet and an environmental report for each company, and an industry report with selected information for all companies.

Computer access to a computer simulation game model by players would put them in the position of the game administrator with access to the past decisions and current positions of all competitors. This would abrogate the our-company-only learning point of view of players. Therefore, the simulation of the simulation" was limited to only those decisions and reports seen by players in the course of their normal game play. This meant that players representing one competing company were allowed to alter a few variables controllable by competitors. These variables were limited to those market interactive decisions (price, salesmen, advertising, and product quality) that are revealed to all players in the industry report. Players are not allowed to see or manipulate operating or financial decisions of competitors.

Thus, with limited simulation of the simulation before the official decision, players may ask, "What if competitors do thug-and-go regarding price, salesmen, advertising, and product quality, and if we do thus- and-so for any or all of our decision elements?" and get an answer within minutes displayed on television like (CRT) computer terminals. Additional services to players include the opportunity to repeat the trial simulation as often as desired, to start from their first trial or from the latest trial, to simulate more than one period ahead keeping decisions the same or changing them adaptively, and to secure a printed copy of their efforts. This simulation of the simulation service to players has altered player behavior, as will be reported later. First, development and implementation details will be described.

Software and Implementation

The computer programs for IMAGINIT were written in FORTRAN: a master FORTRAN version requiring a medium- sized computer and a segmented FORTRAN version adaptable to minicomputers. Unfortunately, the only interactive computing via terminals at the author's location[1] was a minicomputer that provided only the BASIC computer language. Official simulation game runs were (and still are) run on a central large computer using the master FORTRAN program. Data input and carryover for official runs is by means of punched cards; output is computer-printed and hand distributed to players.

The first step fn developing this interactive game decision tool was to translate the IMAGINIT FORTRAN program to BASIC and to write a minicomputer control program in BASIC. Thereafter interactive and service features were added. All this took about two years and two graduate assistants. The final result enables an IMAGINIT player team before finalizing an official decision at each stage of play to:

1. Simulate new period consequences as if all past period decisions remained unchanged.
2. Simulate new period consequences altering (or not):
   a. Any of the team's decision elements.
   b. Four market variables (price, salesmen, advertising, and product quality) for any competing team.
3. Repeat the new period simulation changing decisions from the last trial, thereby allowing a change in a single element without reentering the entire decision.
4. Go back to the old period decision situation and start over.

[1] This work was done at Texas Tech University where the interactive computer is located in the College of Business Administration building. It is a Hewlett- Packard 2000 time-sharing minicomputer with 32 terminals (26 CRT terminals and four typewriter-like hard copy terminals all in one laboratory room, and two telephone access lines for either type of terminal). The central computer, located acro8s campus, is an ITEL AS/6.

5. Simulate as many as six periods ahead varying (or not) any of its own decisions and the four market variables of other teams.

6. Simulate at any convenient time and as often as desired, limited only by availability of terminals.

7. Continue simulation of the current decision after the official deadline until the new period data from the central computer is loaded into the time-sharing minicomputer. This allows after-thought simulation of a final decision since new period data are not entered at the end of play.

The above services to player teams is available only at CRT terminals and, to conserve terminal usage, at only one terminal per team at a time. A four-player team cannot use four terminals. The current simulation for each team is independent of the simulation activities of other teams so that "what if" activities by one team do not affect "what if" trials of competing teams. Displayed on the CRT screen is a replica of the official paper-and-pencil decision sheet with the most recent values for each of the twenty-eight decision elements, i.e., the display looks like a filled-in decision sheet. Players via the keyboard change or not the values as they skip a small white square (called a cursor) from value to value. Input errors are caught by the computer and input is requested again while the cursor stays at the same decision sheet position.

When for one team decisions on the CRT screen are altered as desired, the minicomputer run8 the simulation game models including hypothetical interactions for all competing firms, and displays on the CRT screen the output results, but only for that team's company plus the end-of-period industry report that shows selected results for all firms. Subsequent runs of the same or additional periods with decisions value changes are obtained by answering questions asked by the computer.

Players at any time may opt to obtain a printed copy of the CRT screen reports by logging off the CRT and logging on a printing terminal. All these features are handled by the interactive control program which calls on IMAGINIT model program segments only as needed to produce company and industry results and reports.

Security

To prevent access by one player team to the non-public decisions of another team (the public decisions being those shown on the industry report), players at a terminal are restricted to seeing the company reports for their teams only. This is accomplished by assigning a unique minicomputer account number to each team. However, the account number is not secret because it includes the team's usual identification number.

To prevent teams from logging on competitors' account numbers and thereby accessing otherwise private company decision A, two passwords are assigned each team. One password is required by the minicomputer system itself and 18 created by computer personnel. The other password is created by the simulation game administrator and is checked by the IMAGINIT control program. The minicomputer password is relatively permanent during a semester, while the IMAGINIT password can be changed at any time by the administrator. Thus two level security is provided, with one level being changeable promptly should a password leak occur.

The computer programs themselves are secured from tampering by players by means of automatically logging players on at terminals directly into the control program and logging them off when their simulation activities are concluded. Players cannot use their simulation account numbers to write BASIC programs as students do in other courses.

Administrative Services

Service routines programmed into the interactive simulation system assist game administrators by performing the following functions:

1. Passing card input directly from the central computer to the minicomputer.

2. Loading card input (either from the central computer or from the minicomputer card reader) into files for appropriate player team account numbers.

3. Creating, listing, or altering passwords.

4. Copying industry data from one set of account numbers to another. This enables the administrator to work with any player industry without interfering with players by copying an industry to the administrators accounts.

5. Displaying or printing instructions for using the system.

Administrators receive these services through interactive questions and answers and, like players, need only know how to log on with an appropriate account number. Neither administrators nor players need to know how to program a computer.

Player Performance

Since initial implementation of the interactive simulation of the simulation, player performance, judged by the grading criterion of generated stock market quotation, has increased. In some cases, the increases have been dramatic, with teams generating market quotes as much as double previous highs for comparable industries. On the down side, only slightly fewer teams generate dramatically low market quotes. Apparently, availability of trial simulation of decisions before finalizing official decisions greatly assists otherwise good performance but doesn't do much for otherwise bad performance.

Player Behavior

What players do as they play the game ha8 changed. Before simulating the simulation was available, players met tn areas provided at assigned times and elsewhere at times and places of their choice. Now many go directly to the terminal room and use the simulation system while meeting as a team. A few ocher teams meet as before to decide what they will try before going to the terminal room.

Game-training exercises assigned before allowing players to use terminals include computation of cash balances, inventory levels, plant capacity, overtime or shift changes, and pro forma financial statements. These exercises are intended to provide analytical tools to assist players in making decisions. Once players have access to terminals, use of these decision aids virtually stops. Players merely try out a decision and see whether they run out of cash, incur stock- outs or excess inventories, add a shift, or pay overtime. Of course, the terminal itself provides not only forma financial statements but also trial environmental and industry reports.

Use of the terminal is usually by the entire team, up to four persons huddled around one CRT. Some teams specialize and one player will use a terminal at a convenient time. In this case, he will usually obtain a printed copy of his best efforts that he takes letter to a team meeting before the official decision deadline. As play progresses and competition becomes more intense, players are more sensitive to security. Some shield their CRT's with their arms and bodies to prevent nearby competing players from "spying. Others construct paper shields through which only their team members can see the CRT display. More banter among teams occurs in the terminal room than previously in the more private meeting areas. Interaction with the game administrator is more frequent in the terminal room.

Whether player teams spend more time making official decisions than before is not known, but it has been observed that the amount of time teams use the terminal varies greatly.

In recent past plays, the amount of terminal time (as recorded for each account number by the minicomputer) has ranged from a low of 64 total minutes (or an average of 8 minutes per decision) to a high of 2380 minutes (or an average of 264 minutes per decision). Overall average terminal usage for those plays were 802 total minutes, which is an average of 98 minutes per decision. So far the only apparent correlation between terminal time and player performance is for teams that combine analytical effort away from the terminal with time on the terminal. Some of these teams have generated outstanding performance as noted earlier.

CONCLUSION

That availability of simulation of the simulation has enhanced player rationality (as defined earlier) and reduced decision guessing is evident from increased performance and the fact that tentative consequences of several alternatives are seen by players during terminal usage time.

A side benefit, as some players have reported, is increased appreciation of what computers may do for them in their later careers.

Whether simulation of the simulation enhances all learning objectives of simulation gaming remains to be investigated. Observation of player behavior to date suggests that some players are substituting computer services for analytical thought processes, while others use the detailed hypothetical consequences to generate even finer decision analysis, but in somewhat specific and narrow contexts such as manipulation of only one or two variables at a time. It is possible, but not con- firmed, that these computer services may stimulate other kinds of analytical thought such as consideration of a larger number of alternatives and alternatives that are wider ranging in scope which encompass not only the totality of the firm and its environment but also extend to longer time horizons.

Future

With interactive online time-sharing simulation in place and operating as a representation of the official game model, an evolutionary next step is incorporation of data manipulation services and analytical models to provide a complete decision support system. This step would require development of a data base that could provide current and longitudinal input for decision models, both from historical play and from hypothetical "what if play to a relevant time horizon.

REFERENCES

[1] Barton, Richard F. TEE IMAGINIT MANAGEMENT GAME, (Lubbock, TEXAS: Active Learning: 1978).