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THE DEVELOPMENT OF ALGORITHMIC FUNCTIONAL BUSINESS GAMES

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ABSTRACT

This paper traces the author's work on computerized algorithmic business simulations i.e., ones which include concepts and algorithms for Incorporation into the simulation structure itself. The types of decisions and algorithms involved in three widely used simulations are described. All three games were first programmed on mainframe computers, and one, PROSIM, has been put on the P.C. In the revised PROSIM, now in press, trainees will also be given a decision support system, which is a prestructured Lotus 1-2-3 disc enabling use on the computer to solve quickly the algorithms for making better decisions in the game.

INTRODUCTION

One of this author's major areas has been developing functional business games which we call "algorithmic" for over two decades. The purpose of this paper will be to describe these training endeavors from their inception to our most recent venture in the new age in which the Personal Computer (PC) will assume a central role in business gaming.

Over three decades ago, in 1957, the American Management Association developed the first practical business game the Top Management Decision Simulation. This first game and many of its later counterparts simply provided:

1. Students in colleges or universities or managers in industry with a set of participant instructions indicating the rules of the game, the game environment, the decisions they could make, any constraints on how much or how little they could spend in making each decision, etc.

2. A hand-scoring mechanism or computer program for calculating the results of each set of decisions by the college instructor or industrial trainer.

What was not provided in most training simulations was any hint of ideas, concepts or quantitative analytical tools (algorithms) which would be useful in playing the game. These learning situations simply resembled the older Harvard Business School philosophy of just giving students cases -- one after another -- without providing a theoretical and/or analytical underpinning for analysis of the cases.

HISTORY OF THE ALGORITHMIC IDEA

In 1962, this writer was teaching a senior level business policy course to undergraduates using the then popular UCLA game #3. He was shocked when groups of seniors, who had been exposed to breakeven analysis at least two or three times during their college curriculum when informed by the instructor that they were losing money because they were producing below their breakeven point simply responded: "What's that?' This experience led to the development of mimeographed analytical tools specifically designed to show how concepts and algorithms which they had previously been taught such as breakeven analysis could explicitly be used in making better decisions in the UCLA #3 learning experience.

The above experience led to formulation of the question; "Why wouldn't it be possible to design a computer simulation with preplanned concepts and algorithms built into the materials describing a game so that trainees would have the theoretical and analytical background to play?' An affirmative answer to this question led to the development of a trilogy of what we have chosen to call algorithmic games i.e. , the concepts and algorithms from various academic disciplines were integrated with the game rules and hypothetical game environment.

MARKSIM

Our first, and possibly the first algorithmic computerized functional game was MARKSIM: A Marketing Decision Simulation which was published as a game text in 1964 (P.S. Greenlaw and F.W. Kniffin, 1964). MARXISM was used widely in colleges and universities and to a lesser extent in industry and lived until the ripe old age of 20 before it finally went out of print in 1984.

The basic decisions MARKSIM called on game participants to make each period were:

1. National advertising

2. Debt payment

3. Five marketing research item purchase decisions

4. Quality of product in $

5. Price

6. Units of production

7. Shipments to distribution centers, and

8. Advertising allowances to retailers

As a theoretical and algorithmic background for making these decisions, chapters in the text were devoted to such simple algorithms as return on investment (ROI) to a provision of an inventory planning algorithm in the firm's distribution channels to a fairly sophisticated method of profitability projections for all demand levels that the MARKSIM firm might fact. Thus, a fairly wide set of concepts and algorithms were made available to aid the MARKSIM decision maker. There were some algorithmic limitations here, however, for we had to develop new analytical tools geared just for MARKSIM which had no real world counterparts. We attribute this as mostly due to the subjective nature of marketing as opposed to the more quantifiable characteristics of our second two algorithmic games to which we will now turn our attention.

FINANSIM

Finance is an area which lends itself to quantification to a much greater degree than marketing, and shortly after the completion of MARKSIM an even more algorithmic functional game was envisioned in the field of finance FINANSIM: A Financial Management Simulation. The game was first published as an interactive game text in 1967 (P.S. Greenlaw and M.W. Frey, 1967) and was later revised in 1979 (P.S. Green- law, M.W. Frey, and I.R. Vernon, 1979). The basic FINANSIM decisions were:

1. Purchasing up to three units of each of three capital improvements

2, Expansion of plant and machine capacity

3. Producing units

4. Purchasing or selling of marketable securities

5. Acquisition of 3-, 4-, and 5-year bank term loans

6. Issuing or retiring debentures

7. Issuing common stock, and

8. Paying dividends

To aid FINANSIM decision makers in making their decisions, the following algorithms, among others, were incorporated into the text: ROI; the DuPont Formula; ROE; current ratio; pro forma income statements; the cash budget; the pro forma position statement; an algorithm for multiple income projections, one for multiple cash budgets, and one for multiple position statements; capital budgeting models including pay- back and present value analysis; algorithms with respect to the cost of alternative methods of financing e.g., debt vs. equity financing; and a debenture retirement algorithm based or present value analysis. As may be seen from this listing, FINANSIM was much more algorithmically oriented than MARKSIM, and many of its analytical tools could be applied with little modification to real world problems.

PROSIM

The third member of the "SIM" family, PROSIM: A Production Management Simulation was published in 1969 and is still in use (P.S. Greenlaw and M.P. Hottenstein, 1969). Simulating a production or operations management environment, PROSIM called on managers to make the following decisions each period:

1. Quality control expenditures

2. Plant maintenance expenditures

3. Regular raw materials order

4. Expedited raw materials order

5. The assignment of up to 4 workers on each of two production lines

6. Deciding for each of these workers:

    a. Whether to be trained or simply work

    b. Number of hours scheduled (0-12), and

    c. Product to be working on (i.e., the product X, Y, or Z -- to be assigned to the machine).

With production management more quantitative like finance, PROSIM also incorporated chapters incorporating such production management algorithms as EOQ; dynamic programming for product scheduling; the order point and order cycle methods of inventory control; incremental cost analysis for quality control and plant maintenance; and total standard costs as opposed to total actual costs to provide an overall measure of efficiency. (It should be noted that the above description will need updating as a revised edition of PROSIM is now in press.)

THE TRULY ALGORITHMIC SIMULATION

The above games were specifically designed to provide concepts and algorithms to enrich the participation in business simulations. In all three, however, the trainee would have to use the algorithms designed to aid in the play via hand calculations or with the aid of electronic or solar calculator. With many present value or EOQ equations to manipulate, however, doing a thorough job of algorithmic analysis could be quite time consuming. This problem will be largely overcome, however, in the revision of PROSIM is now underway, (P.S. Greenlaw, M.P. Hottenstein, and C.H. Chu, 1989).

In the revised PROSIM two significant changes have been made. First, a diskette is made available to each participant so that he or she can play the game on a PC. This adds a new dimension of realism since the trainee can interact directly with the computer rather than hand in decision forms to an instructor or computer lab assistant. Simply giving trainees "hands on" experience with the PC, of course, is by itself a basic and important learning experience.

Second, we have made PROSIM more algorithmic by providing a second diskette which contains most of the algorithms covered the game text. These "decision support systems" as we have named them which are of the prestructured Lotus 1-2-3 family, enable the participants to have the computer solve the algorithms for them when the appropriate data is fed in. Thus, (1) solving the algorithms directly on the PC as well as (2) playing PROSIM on the computer adds a sense of realism not present in our algorithmic functional games before. (Until this revision was developed, all of our games were written in FORTRAN for use on mainframe computers.) It also means much less manual calculation on the part of the participants. For example, to find an exponential weighted moving average (EWMA) in forecasting product demand, participants simply plug the values they believe are appropriate into the EWMA decision support system and get results extremely quickly. No more need to pull out the electronic calculator and have to make a series of calculations.

PC'S, DECISION SUPPORT SYSTEMS, AND LEARNING

It is this author's opinion that algorithmic games will be enhanced considerably by the use of the PC which, in turn, opens the door to the possibility of decision support systems. We will now examine more specifically why this is so in terms of principles of learning. Learning theorists and psychologists have developed a number of "principles of learning." Recent years have witnessed an increase in the principles in which learning, transfer, and retention of materials can be accomplished. Some of these are as follows.

Feedback

The PC offers an opportunity for students or trainees to make a gaming decision (using the decision support analytical tools), and print out their results in a much shorter time than ever before. Students can repeat behaviors very frequently and get very quick feedback each time to enable them to know their results favorable or unfavorable.

Motivation

Most students seem fascinated with the PC (although there are some who are afraid of Having a PC to work on plus a decision support system which eliminates all those calculations by hand (with or without an electronic calculator) simply adds more to the motivational possibilities of algorithmic games.

Transfer of Learning

There are two popular theories of the transfer of learning from the training place to the real-life situation for which the training is directed. First, is learning by identical elements. This theory maintains that for transfer to occur, identical elements must exist in both settings. The second theory is transfer by principle. This theory maintains that transfer of learning can occur without identical elements as long as principles are learned which can be generalized to other situations. Transfer by identical elements is generally considered the more effective of the two types of transfer. With respect to gaming, when trainees, for example, read about the EWMA, then plug values into the decision support ays- tem and finally use the EWMA results in making their highly realistic <u>PROSIM</u> set of decisions, considerable transfer by identical elements appear much more so than with the predecessor <u>PROSIM</u> without PC or decision support systems.

Learning by Doing

A basic learning principle is that of learning by doing. When individuals are given the opportunity to actively participate in the training, they will tend to learn the task more effectively, assuming of course the learning situation is properly designed. For example, if an individual wants to learn how to change a flat tire, there is nothing like (directed) practice in taking the flat off the car and changing it with the spare. Similarly, after having read their game materials, there is nothing like a decision support system on a PC to give trainees much doing rather than a much more passive sitting back and penciling in their decisions on a form to be given to a game administrator. For example, if students study EOQ In their game text, solve for Q by means of the decision support system, and then incorporate the resultant value into their inventory planning, a lot of doing and under proper learning conditions learning by doing is taking place. We introduce the phrase "under proper conditions" here to emphasize that throughout gaming experiences "learning breakdown" can take place. For example, if students have to wait in line an hour to use one of their university's shortage of PC's. practically all we have talked about positively in this paper may be rendered obsolete.

Repetition

The PC Decision Support System experience will permit the making of quick good decisions. To take EOQ again, students having learned what EOQ is either in class or in their gaming book or both, can quickly place their decision support system diskette into the PC, get their required Q and then quickly get their other decision support system values and make their game decisions. Thus, there will be more time affordable to make more decisions support analyses and game decisions ceteris paribus.

OVERVIEW

When discussing gaming one must look at what is going on in terms of (1) educational philosophy and rationale, and (2) technology. Without technology we could not have jumped from rather simple and sometimes crude hand-scored games to sophisticated and complex computer ones, nor could algorithmic games of the type we have been discussing been able to be developed. Similarly, decision support systems, more learning by doing, feedback and so on would not have been possible without the
PC.

It is important to conclude by saying that decision support systems simulation are not the only kind of value they are just one of the many types which have been developed in the technological and educational milieu of the past thirty years. This author still uses role playing, computerized exercised (J.W. Boudreau and G.T. Milkovich, 1988) and other experiential exercises in both senior and graduate courses in a large university. Compleat Educators will do themselves justice only by becoming familiar with all major types of experiential learning and then choosing from among them to meet their specific objectives within the constraints of their technology.

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