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COMPUTERIZED FOREST RESOURCE MANAGEMENT GAMES: AN OVERVIEW AND ASSESSMENT

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Introduction

The purpose of this paper is to discuss computerized management games and their use in teaching forest resources management. The discussion will key on two general themes. The first of these themes is the notion of using competitive simulation models (i.e., management games) to assist in teaching forest management. And, owing to the general purpose of this workshop, the second theme concerns the use of digital computers as they are used in implementing the games in a teaching environment. In order to adequately discuss the implications and ramifications associated with these two points I will first discuss the use of computerized management games and provide some necessary definitions and concepts of gaming. This will be followed by a review of some existing forest management games with special emphasis devoted to a description of the Purdue University Forest Management Game. Lastly will be a discussion of our experiences with the Purdue Game in a senior level forest management course and some general comments concerning the place of gaming in the education of forest managers at both the undergraduate and graduate levels, and the continuing education level. These introductory comments should have made it clear that while I intend to discuss our experiences with the Purdue Forest Management Game, I also plan to extrapolate from these experiences to more general comments concerning the pros and cons of the gaming methodology itself. Obviously, however, these two topics are by no means mutually exclusive.

History, Definitions and Concepts of Gaming

Simply stated, management games are competitive simulation models where several teams compete against each other in a simulated environment controlled by certain game rules. An alternative definition is that a management game is a case study

with feedback and a time dimension added (Carson, 1967). As these two definitions imply, games provide dynamic environments allowing students to gain valuable experience in a shorter time than is possible in real world situations.

The origin of management games is normally traced back to the development of war games. Although the history and origin of war games are somewhat unclear, chess and similar board games are generally acknowledged as the forerunners of modern war gaming procedures. As war games evolved, actual maps were introduced to replace the earlier board war games (Cohen and Rhenman, 1961). Military war games were introduced into the British Army in 1872 and into the United States armed forces soon thereafter (Thomas, 1957). Both Japan and Germany made extensive use of war games in the Twentieth Century (Jackson, 1959).

In addition to the development of war games, the recent availability of the digital computer and the development of the field of operations research also greatly influenced the development of management games. Greenlaw, Herron, and Rawdon (1962) point out that reasons for this were: (a) the operations research technique of simulation is intricately involved in the gaming approach, and (b) the operations research specialist was originally more competent than the educator in utilizing the facilities of a digital computer.

The American Management Association (in conjunction with the International Business Machines Corporation) developed the first management game in 1956 (Ricciardi, et al., 1957). Other early games originated with Andlinger (1958) and Schrieber (1958). The Carnegie Tech Management Game, developed during 1958-59, was probably the first really "complex" management game, requiring players to make over 300 decisions per period (Cohen, et al., 1964). Those interested in investigating any of the hundreds of games developed during the 1960's may refer to one of the bibliographies prepared by Greenlaw,

Herron and Rawdon (1962), Cohen and Rhenman (1961), Kibbee, Craft and Nanus (1961), IBM (1966), Hartmann (1966), Sord (no date), Naylor (1968), Graham and Gray (1969), Johnson (1969), Tansey and Unwin (1969), Twelker (1969), Werner and Werner (1969), or Zuckerman and Horn (1970).

To conclude this introductory material I would like to briefly review the pros and cons of management gaming along with some of the more general concepts of gaming. The literature abounds with articles explaining the tremendous popularity of management games. Kibbee, Craft and Nanus (1961), believe that two unique characteristics which enable games to contribute so powerfully to management education are: (a) the novel use of the time dimension, and (b) the objectivity of the feedback. The use of a computerized simulation model permits one to compress the time horizon, permitting students to view the effects of their earlier decisions over an extended period of time. Because this is an obvious observation it does not merit any further discussion.

The incorporation of the gaming concept into the instructional process creates a dynamic teaching environment which subsequently enables the student to make decisions and to test their effects on the simulated management environment. Further, as Cohen and Rhenman (1961) state, "the simulation of the environment to make possible feedback of the results of their actions to the players is the fundamental game idea...".

Another important feature of management games which undoubtedly has increased their effectiveness is the high degree of involvement and motivation students exhibit when playing a game. This motivation often puts students in a state of mind where they become more receptive to new ideas and new techniques. Further, games encourage students to utilize some of the quantitatively-oriented decision-making techniques learned in other courses, but perhaps never applied to a "real-life" problem.

Another reason often mentioned for using games is that they vividly point out the need for team organization, control and communication (Fulmer, 1963). Other reasons, as listed by Calvert (1971), are that games bring students into contact with a computer, illustrate the importance of considering uncertainty in the decision-making process, illustrate the importance of obtaining relevant and timely information, and provide students with an opportunity for effective intergroup learning with peers.

Although the overall concensus of many articles and books that I have reviewed indicates that management games have a place in the classroom and that they can be used as effective teaching devices, this does not infer that other educational methods are invalid or of lower value than management games. In fact, there are numerous limitations often associated with the use of management games. Among these are: (a) high cost of instruction, (b) extensive development time, (c) problem of interpersonal rivalries which may develop due to intensive involvement, (d) high level of abstraction, (e) tendency to overemphasize quantitative factors in lieu of qualitative factors, (f) danger of transferring game results to real life situations, and (g) possibility of teaching erroneous concepts, facts or relationships that may have been incorporated in the model in a somewhat arbitrary fashion. Perhaps one of the most common criticisms of games often cited is that little empirical evidence exists that games do, in fact, teach whatever they are intended to teach. However, there has been a dearth of successful objective validation studies for evaluating the effectiveness of other teaching methods (i.e., lectures, case studies, laboratories) as well. Speaking to this point, Calvert (1971) states "while it is true that the positive aspects of management games have yet to be shown in objective research or at least in regard to being a better or equal method of teaching compared to the use of other educational techniques, a crucial point that is many times overlooked is the fact that

a game administrator, usually the class instructor, is on the scene...he has the responsibility for explaining the game model limitations and biases and preventing the erroneous or too literal transfer of game results to real life business situations." Many educators, sociologists and behavioral scientists are attempting to evaluate the educational value of management games. Those interested may consult a recent book entitled "Simulation Games in Learning" (1968) or consult the journal entitled Simulation and Games: An International Journal of Theory, Design and Research. Both sources are devoted to gaming and the evaluation thereof.

Management games normally fall into one of two general classes: (a) total enterprise games which emphasize decision-making at a top executive level where management of the total firm is the objective, and (b) functional games which emphasize lower or middle management in one particular area of a firm. Thus, instead of making decisions which affect the entire firm, students are limited to making detailed decisions affecting only one functional area of the firm. Most forest management games, including the Purdue University Forest Management Game, fall into this latter class.

Many other characteristics are often used to classify management games. Among these are: (a) manual versus computer models, (b) the number of players per team and the number of teams per game, (c) the length of the planning period, (d) single versus multi-product models, and (e) the orientation of the game for educational versus research objectives. This last point is quite important, for if the basic motive for constructing a management game is for educational purposes then the appearance of reality to the players may be more important than the realism of the model. As stated by Kibbee, Craft, and Nanus (1961), "the degree of reality needed in the model depends on the training objectives." Similarly, the distinction between verisimilitude and reality is related to the intended difficulty

of the game as well as to the objectives of the game. Therefore, it is necessary to consider the purpose, the trade-off between verisimilitude vs. reality, and the expected level of difficulty when developing or evaluating the potential of any particular management game.

Before closing this somewhat extended section on the concepts of gaming, I would like to mention four different ways management games can be used. These four ways, after Graham and Gray (1969), are:

1. Teaching specific items such as the importance of planned and critically timed decisions or the use of a particular technique like linear programming or PERT.

2. Teaching general behavioral factors such as the importance of organization, control, communication, or matching tasks with people.

3. Teaching the power of modeling and the advantages of adopting a scientific approach to decision-making.

4. Generating a high degree of involvement where students can integrate specialized functions that they have learned in other classes.

Obviously, the items in this list are not mutually exclusive--a well structured game may succeed in all of the areas.

Forest Management Games

In the preceding section I have presented some of the pros and cons of gaming and some of the basic characteristics and concepts of gaming. Now, I would like to specifically discuss forest management games with special reference to the Purdue University Forest Management Game. Although a discussion of all available forestry-oriented management games is beyond the scope of this paper, I would like to list some of them and give a short description of each.

1) The Virginia Tech Industrial Forestry Simulator and Management Game. This game places the student in the position of a woodlands manager where he must make decisions concerning both wood procurement activities and forest management activities on company owned land. Given estimated budget levels for each of the next n years, the student makes his decision, runs the game for n years, and receives his output. If he satisfies mill requirements with no budget deficits he "wins". This program, written in Fortran IV for the IBM 360/65, is available to interested users. (Thompson and Simpson)

2) Pulpwood Procurement Simulator. This game, concentrating on wood procurement activities, charges each team with producing an adequate wood supply of a suitable species composition for the pulpmill to which it has been assigned. Since the wood is assumed to be harvested by independent suppliers, each team must make suitable contracts with these suppliers in order to insure a continuous wood supply. To accomplish this latter objective, each team must usually set up a quota contract network whereby certain suppliers contract to deliver a certain volume of wood at a set price. The game is programmed in Fortran IV for the IBM 360/67. (Borden, 1970; Chambers and Borden, 1969)

3) The Dynamic Forest Products Management Simulator. This game places the student in charge of a forest products firm which makes two plywood products. The producers acquire logs by making oral bids for public timber. Upon converting the logs into veneer and subsequently into the two plywood products, the producers sell the material to wholesalers. The wholesalers in turn market the plywood products in different sales regions. Student teams may experiment with different inventory rules, manufacturing processes and marketing and pricing strategies. The game is programmed in Fortran IV for the IBM 360/50. (Ramsing, 1970)

4) The Harvard University Forest Simulator. This well known simulator allows students to manage a forest property for timber production under various operating and economic conditions. This simulator is written in Fortran IV for several computers. (Gould and O'Regan, 1965; O'Regan, 1965; O'Regan, Arvanitis and Gould, 1965; Walton, 1965; Howard, Gould and O'Regan, 1966; Gould, 1967)

Other forestry-oriented management games include a fairly simple game designed to simulate the random occurrences of forest fires in large areas and the effects that the allocation of certain types of available resources will have on the fires[1]. In addition, the U. S. Forest Service is developing a multiple-use gaming model which will be used at the forest level. The model entitled SNAFOR (Simulated National Forest Region) is an outgrowth of the earlier Land Classification and Land Management Game (LACLAG) also developed by the U. S. Forest Service (Row and Schmelling, 1971; Hull). The basic objective of both models is to simulate a total national forest management situation including regional, ecologic, social, economic, and political interactions[2]. Others developing games include Peter Dress, School of Forest Resources, Pennsylvania State University--a recreation site development game, and William Pierce, School of Forestry, University of Montana--a timber management game. In addition, Walters and Bunnell (1971) and Giles and Lobdell have developed wildlife management games.

Lastly, I would like to mention the gaming activities at the Center for Quantitative Science, University of Washington. During the summer of 1970 the Ford Foundation sponsored an interdisciplinary workshop on resource management games. Under the

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1) Personal communication with William Bentley, School of Natural Resources, University of Michigan, Ann Arbor, Michigan.

2) Personal communication with Dick Hull, Eastern Region, U. S. Forest Service, Milwaukee, Wisconsin.

overall guidance of Gerald Paulik, fifteen modellers came to the campus and worked on various types of management games dealing with forestry, fisheries, ecology, water and wildlife. The ensuing package of programs has been tested at Florida State University, the University of Michigan and the University of Washington. Those interested in this package of teaching games may contact either Paulik or myself.

Purdue University Forest Management Game

So far this afternoon I have attempted to introduce the subject of management games and I have briefly reviewed some of the available forestry games. Now I would like to discuss our use of the Purdue University Forest Management Game. The original version of the Purdue University Forest Management Game was developed during 1967-69 under the guidance of Otis Hall. Since then, the game has undergone several revisions and, in addition, a second simulation model called The Forest Management Simulator has been developed to supplement the original gaming model. These two models now constitute the total package. Although I don't intend to spend a great deal of time describing the details of either model I will briefly outline the basic structure of the gaming package.

The purpose of the Purdue University Forest Management Game is to simulate the operations of an industrial forest property so that forest management students may observe how the various biological and financial factors associated with operational forest management interact to affect the behavior of the forest system. The game concentrates on the preparation of an annual budget of expenditures and an annual schedule of management activities. Thus, it emphasizes operational or middle management activities more strongly than policy formulation and long-range planning (Bare, 1970a).

The Forest Management Simulator is designed to counter this orientation and to instill an appreciation for the long-term consequences of alternative management strategies. Since

the determination of long-term goals, objectives and consequences of alternative management strategies must be evaluated prior to their implementation on a short-term basis, the Forest Management Simulator necessarily is used prior to the management game itself. (Bare, 1970b)

Given the pulpmill's annual requirements for roundwood and the expected annual budget, each team sets out to determine how it will manage its forest district. Using the Forest Management Simulator, teams are able to evaluate the consequences of decisions relating to regeneration and site preparation, thinning, regeneration delays, methods used to compute the allowable cut, methods used to allocate the allowable cut to specific compartments, and the interval between updates of the allowable cut. Using a predetermined discount rate the simulator generates the net present worth of all cash inflows and outflows during each simulation run. After extensive experimentation with the simulator teams select that strategy which will: (a) generate a satisfactory cash flow stream, (b) satisfy the requirements of the pulpmill, and (c) produce a forest capable of sustaining production at the desired level. Lastly, to be feasible it must be possible to implement any selected strategy within the expected budget.

Following experimentation with the long-term simulator the student teams play the management game and attempt to implement their strategies on a year to year basis. Since operating funds are allocated as a function of the previous years' performance, teams are generally unable to implement their strategies as originally planned. As time progresses the discrepancy between long-range plans and annual plans normally becomes increasingly greater. Therefore, after simulating a period of five years, each team is given an opportunity to alter its long-term management strategy. The Forest Management Simulator is used in developing this new management strategy just as it was for the original strategy. I should also add that the game

moderator uses the Forest Management Simulator to determine the annual allowable cut for each district based upon the management strategy adopted for the particular district.

Experience with the Purdue University Forest Management Game

I now want to present some personal views concerning the use of computerized management games based upon my experiences with the Purdue gaming package. For the past three years I have used the Purdue Forest Management Game in a senior level forest management course. Although the Forest Management Simulator has only been used during the past two years, there is little question in my mind that the addition of this simulator greatly improves the total gaming experience.

First, I feel that exposure to computerized simulation models has been a very beneficial consequence of the gaming exercise. To date the game has been implemented on batch, remote batch and time-sharing computer systems. However, due to the number of decisions required during each year of simulated play and the forethought required prior to making decisions for any particular year, the game may be better implemented on a batch or remote batch system than on a time-sharing system. It seems to me that games best suited for time-sharing systems are those where only 1 or 2 decisions requiring little study are necessary in order to play the game. Of course, the advantage of any time-sharing system is rapid turnaround time once the decisions are entered.

Second, students gain valuable experience in the total decision-making process. By this I mean the process of defining a set of goals and objectives, identifying a set of alternatives which if implemented will satisfy these goals, evaluating each alternative using some pre-determined criterion, selecting the most satisfactory alternative, and finally implementing the decision. I feel that exposure to this process in the context of a specific problem-solving situation is one of the most lasting and beneficial rewards that students receive from participating in the gaming exercise.

Third, I feel that exposure to a model which attempts to integrate knowledge learned in other courses, and stimulate application of this knowledge to a specific problem is a valuable contribution of the gaming exercise.

Fourth, the act of playing the game seems to stimulate or motivate students much more than does a traditional lecture or case study course. Of course, all students are not motivated to the same degree. I think the reason for this (to a large degree) is that we are using the computer. Since some students distrust or dislike computers, they tend to be "turned off" by the gaming exercise. The game also seems to stimulate the use of quantitative methods. I think this is due to the student's belief that since we are using computers only quantitative information is relevant. This implies to them that quantitative analysis is appropriate and hence they are stimulated to do so.

Lastly, the Purdue gaming exercise provides students with valuable experience in both preparing a long-term plan using modern simulation methods and in implementing the plan through the preparation of an annual budget and a compartment by compartment schedule of management activities. I don't yet know the impact of the gaming experience on the student's later professional job development and advancement but there is little doubt in my mind that the exercise does give the student an opportunity to apply his knowledge and talent within a decision-making context.

Concluding Remarks

This afternoon I have discussed the pros and cons of gaming, briefly reviewed some existing forest management games, described the Purdue University Forest Management Game, and related some of our experiences with the Purdue Game. Before concluding my talk I would like to say a few additional words about some potential uses of the Purdue Game and management games in general.

Most of the discussion concerning our use of the Purdue Game has centered around its use in a senior level forest management course. In using the game within this type of environment the emphasis has been on the use of the game and not on an evaluation of the model, how it is constructed, or how it operates internally. However, we plan to use the game within this latter context in our graduate level forest management course this year. Instead of playing the game per se, graduate students will investigate how the model is constructed, how it operates, how embedded assumptions effect the behavior of the model, etc. We also plan to critically review several other existing simulators in an effort to assess the current state of the art of forest management simulation models.

Another type of user who could benefit from playing management games is the practicing forest manager. We have used the Purdue Game (not the Forest Management Simulator) in a continuing education short course where we placed more emphasis on a critical review and examination of the game than we did upon its actual use. However, the use of any management game in such a short course is dependent upon the objectives of the course and the background and experience of the course participants.

Hopefully, these concluding remarks have made it clear that to a large degree the objectives of any particular course and/or the previous experience of the course participants dictates the manner in which a particular management game is used.

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