MANAGEMENT GAMES AND THE TEACHING OF FARM MANAGEMENT

JOHN W. LONGWORTH*
University of Sydney

The concept of a farm management game is explained, and the relationships between simulation, games and Monte Carlo techniques are discussed. The potential role of farm management games in improving the teaching of farm management is reviewed. The management game is presented as a dynamic case study.

Management games are a major innovation in management education. The first business game was developed for the American Management Association in 1956,[1] but since then many different games have been developed and are being used in the United States and elsewhere, both for education and research. The earliest farm management game was the result of work at Purdue University in 1964.[2] This paper is concerned with explaining the concept of management games and discussing the role of farm management games in farm management education.

What are Management Games?

A management game is designed to create an exercise in business management. Each game is based upon a more or less realistic model of a business situation which is used to simulate the outcomes of management decisions made by the participants in the exercise. In a typical business management game, the players are divided into teams representing several competing companies. Each team receives a summary of the financial position and history of its company, together with a general description of the under-lying economic and physical relationships which may be expected to influence the results. The teams must make decisions and allocate the resources available with the aim of achieving their goal, which is usually an increasing share of the market, subject to long-run survival of the firm. The outcomes are then calculated by an umpire often, but not always, using a computer. The underlying model used to determine the results is basically a set of cause and effect formulae, which represent the views of the designer of the game about the functioning of the relevant business situation. The results are presented in the form of financial and physical statements about each firm and about the market. The participants study this feedback and make their decisions for the next period. This process is continued for a number of simulated business years.

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[1] F. M. Ricciardi *et al.*, *Top Management Decision Simulation: The AMA Approach*, (New York: American Management Association, 1957).

[2] L. Eisgruber, *Farm Operation Simulator and Farm Management Decision Exercise*, Purdue University, Agricultural Experiment Station, Progress Report 162 (February, 1965).

There are significant differences between the typical game outlined above and a farm management game. The obvious difference that a farm management game is based upon a model of a farm rather than some other form of business, suggests that a participating team could reasonably consist of just one person. Teams in business games usually consist of five or more people, representing the executives of a fairly large firm. A much more important difference is that the decisions of any one team playing a farm management game will have no effect on the outcomes of the decisions of other teams. Farm management games do not involve interaction between the decisions of participating teams, but this is not to say they are not competitive. Each team manages its own farm under conditions of pure competition and production uncertainty. The competition is to see which team can perform best against this uncertain economic and physical environment labelled 'Nature'.

The number of participants per team and the interaction or non-interaction of decisions are only two characteristics of games. Games can differ in many other features. The type and number of decisions the participants are called upon to make, and the decision period (the real time period being simulated for each set of decisions), can vary from several hundred decisions for a monthly decision period, down to a dozen decisions made on an annual basis. The specific objective of a particular game may range from stimulating interest in an in-service executive development programme to a detailed exercise in auditing. The decision situation created by the game may present top-level executive problems or routine problems at a much lower level of managment. In many games the computational burden makes a computer essential, but games have been designed for hand calculation. As a result of this diversity, it is not easy to classify management games into neat categories.

The loose taxonomic system which has been adopted is to use the word 'game' to describe all simulations which involve human decision-makers. This word is then prefixed by an appropriate adjective to describe the type of game under discussion. For example, 'top-management games' are games in which the environment simulated is that facing top-level management. Similarly, 'functional games' are games used to instruct people about some specific decision-making procedure or function. However, this taxonomy has introduced two problems. First, the unfortunate connotations which surround the word 'game', and secondly, the question whether all management games are in fact simulations.[3]

Games are entertainment. This is the first preconceived notion which arises when one talks about playing a game. Whilst management gaming, as many authors have pointed out,[4] can be entertaining, entertainment is not usually the primary objective. The more useful games involve too much hard work to be lightly dismissed as fun. Nevertheless management games are highly competitive and they do encourage emotional involvement, and therefore are rather like serious competitive sport. The word 'game' also suggests to some people 'game theory'. Since the mathematical algorithms of game theory are rarely any more applicable

[3] A more rigorous but not generally accepted classification system is suggested in S. Eilon, 'Management Games', *Operational Research Quarterly*, Vol. 14, No. 2 (June, 1963), pp. 137-149.

[4] See for example, J. D. Stanley, 'Management Games: Education or Entertainment?', *Personnel Journal*, Vol. 41, No. 1 (January, 1962), pp. 15-17 and 23.

to games than they are to real life, this is an unfortunate association. On the other hand, there is a strong historical link between game theory and the development of management games.[5]

A more fundamental question arises when games are described as a sub-set of the simulation set. From the beginning, the pioneers of management games, such as the original AMA study group, have referred to games as simulations.[6] On the other hand some authors such as Shubik,[7] and Thomas and Deemer,[8] try to draw clear distinctions between the three related concepts of simulations, games and Monte Carlo techniques.

The term 'simulation' has been used to describe almost anything which is not the real thing. The interesting ontological question of what is reality and hence what is simulation, has been discussed by Churchman. Churchman considers the concept of reality as elusive, 'in fact, so elusive that most intellectuals feel some embarrassment about trying to define it. "Reality", like "god", "love", "beauty" and "goodness" is somewhat indecent because it seems too reluctant to fit into any given scheme of categories. Thus, while most management scientists talk about the realism of their models, few would like to commit themselves as to what they are talking about.'[9] Churchman argues that if some formal system 'y' is accepted as reality and there is another formal system 'x', which approximates the real system, it is reasonable to say 'x' simulates 'y', *only* if the predictions about 'y' based upon 'x' are based, in part at least, on non-analytical rules.[10] This, says Churchman, is the only justification for the independent existence of the concept of simulation, since words like 'model' and 'theory' adequately cover all other representations of reality. This parallels the earlier definition of Harling, viz 'by simulation is meant the technique of setting up a stochastic model of a real situation, and then performing sampling experiments upon the model'.[11] Both these views of simulation imply that a central feature of simulation is the selection of certain key parameter values by chance. The technique used to introduce data of a random or probabilistic nature into the simulation model is called the Monte Carlo method.[12]

[5] F. M. Ricciardi, *op. cit.*

[6] American Management Association, *Simulation and Gaming: A Symposium*, Management Report No. 55 (New York: American Management Association, 1961), pp. 5-7.

[7] M. Shubik, 'Simulation of the Industry and the Firm', *American Economic Review*, Vol. 50, No. 5 (December, 1960), pp. 908-920.

[8] C. J. Thomas and W. L. Deemer, Jnr., 'The Role of Operational Gaming in Operations Research', *Operations Research*, Vol. 5, No. 1 (February, 1957), pp. 1-27.

[9] C. W. Churchman, 'An Analysis of the Concept of Simulation', in A. C. Hoggatt and F. E. Balderston (ed.), *Symposium on Simulation Models, Methods and Applications to the Behavioural Sciences* (Cincinatti: South West Publishing, 1963), p. 7.

[10] *Ibid.*, pp. 6 and 12.

[11] J. Harling, 'Simulation Techniques in Operations Research—A Review', *Operations Research*, Vol. 6, No. 3 (May-June, 1958), p. 307.

[12] The term 'Monte Carlo' was first used by von Neumann to describe a procedure he and Ulam had devised to analyse the properties of particularly difficult functions during the Los Alamos Project. See S. Ulam, 'John von Neumann, 1903-1957', *Bulletin of the American Mathematical Society*, Vol. 64, No. 3, Part 2 (May, 1958), p. 34. Monte Carlo is now used rather loosely to describe a range of techniques, all of which involve drawing values from a probability distribution. For a popular discussion, see D. D. McCracken, 'The Monte Carlo Method', *Scientific American*, Vol. 192, No. 5 (May, 1955), pp. 90-96.

Game designers quickly realized that games could be structured around deterministic models. These are models 'in which the outcome of every decision is uniquely determined by the decision, although the mechanism may perhaps not be known to the player'.[13] In view of the Harling-Churchman concept of simulation, can games which do not contain any Monte Carlo computations be considered simulations? The answer must surely be in the affirmative. All systems involving human beings must contain at least a pseudo-stochastic element, given man's limitations in discovering and consistently executing rational forms of behaviour. The gaming system, in which man plays the model, therefore, is a simulation of the real world system in which man pits his wits against his environment.

Kuehn and Day have suggested that all games other than operational games are not simulations, since they do not aim to predict.[14] These authors use the term 'operational games' to describe that class of games used exclusively for the analysis of an operational system.[15] To Kuehn and Day, whether or not the model contains stochastic elements is not important in classifying the game as a simulation; to them it is the objective of the game which is of crucial concern. This is a rather narrow view of simulation because it excludes from the simulation set, all models which are designed specifically to teach or instruct people about a system, including most management games. A more acceptable approach is that suggested by Dawson when he says 'it seems most useful to regard simulation as a general term referring to constructing and operating on a model that replicates behavioural processes; gaming as a type of simulation; and Monte Carle techniques as a process used in some simulation operations'.[16]

Games may be classified as open simulations, in that, many key parameters in the simulation are open to the choice of the player, that is, they are determined exogeneously to the model.[17] In some game models, it has been possible to replace the human decision maker with a set of

[13] R. Bellman *et al.*, 'On the Construction of a Multi-stage, Multi-person Business Game', *Operations Research*, Vol. 5, No. 4 (August, 1957), pp. 482-483.

[14] A. A. Kuehn and R. L. Day, 'Simulation and Operational Gaming', in W. Alderson and S. Shapiro (ed.), *Marketing and the Computer* (Englewood Cliffs: Prentice-Hall, 1962), p. 237.

[15] Originally 'operational gaming' was the term used to embrace 'the use of war gaming in a context broader than that of military situations alone'. See W. E. Cushen, 'Operational Gaming in Industry', in J. F. McCloskey and J. M. Coppinger (ed.), *Operations Research for Management*, Vol. II, *Case Histories, Methods, Information Handling* (Baltimore: The Johns Hopkins Press, 1956), p. 358. This approach persisted at least until 1959. See for example, G. J. Feeney, 'The Future of Management Games', in C. W. Churchman and M. Verhulst (ed.), *Management Sciences, Models and Techniques*, Vol. I (New York: Pergamon Press, 1960), p. 263. However, the suggestion made by Thomas and Deemer in 1957 (*op. cit.*, p. 6) that 'operational gaming' be restricted to describing games used as operations research tools, has now been widely accepted. See, for instance, the comments of K. J. Cohen and E. Rhenman, 'The Role of Management Games in Education and Research', *Management Science*, Vol. 7, No. 2 (January, 1961), p. 159. Kuehn and Day also clearly accept the definition of Thomas and Deemer.

[16] R. E. Dawson, 'Simulation in the Social Sciences', in H. Guetzkow (ed.), *Simulation in Social Science: Readings* (Englewood Cliffs: Prentice-Hall, 1962), p. 8.

[17] The concept of 'open' and 'closed' simulations is discussed at length in G. H. Orcutt *et al.*, *Microanalysis of Socioeconomic Systems: A Simulation Study* (New York: Harper and Row, 1961), Chapter I.

decision rules and thus convert the model into a self-contained or closed simulation. An excellent example of this has been documented by the British workers, Mellor and Tocher.[18] An American farm management game developed by Eisgruber also illustrates how a game model may be converted into a closed simulation.[19]

A major limitation preventing most games from providing the basis for worthwhile closed simulations, is the relative simplicity of the game model. The teaching-learning objectives of gaming have frequently been achieved with much simpler and less realistic models than are required for a closed simulation designed to test alternative real world strategies.[20]

The Role of Games in the Teaching of Farm Management

Much of the practice of management is still an 'art', that is, an applied talent improved by observation and experience. There are, however, many aspects of the managerial process which can be improved by formal management education. The professional discipline of farm management should aim to bring all the modern management aids from accounting to operations research techniques, to bear on the management of farm businesses. Unfortunately formal instruction in this discipline has tended to be technique-oriented rather than practice-oriented.

Management games provide a pedagogical tool of immense potential for presenting the principles and procedures necessary to improve the managerial process. To stress this point the usual model of the managerial process will be used as a framework to suggest how management games may be used to illustrate and teach farm management.[21]

1. *The formulation of goals and objectives*

Every participant in a management game may be forced to appreciate quickly the need to be explicit about goals and objectives. To achieve this each team may be instructed to prepare a statement of their aims before the game commences. At intervals throughout the gaming period, reports on how they have modified their goals after discovering conflicts and inconsistencies may be required. In practice, such explicit goal formulation and review is the hall mark of a successful manager, because it gives direction to the whole management effort. Traditional teaching methods give but token attention to this aspect of management.

2. *The recognition and definition of problems and opportunities*

Research has shown that farmers have considerable difficulty in identifying problems and opportunities.[22] Poor managers encounter many problems as 'forced action' situations and deal with them by *ad hoc* measures. Management is, for these men, chiefly of a 'putting-out-the-

[18] P. Mellor and K. D. Tocher, 'A Steel-Worker's Production Game', *Operational Research Quarterly*, Vol. 14, No. 2 (June, 1963), pp. 131-135.

[19] L. Eisgruber, *op. cit.*

[20] American Management Association, *op. cit.*, p. 8.

[21] Many authors have presented the managerial process as a series of steps. For an example which uses this approach for much the same purpose as it is being used in the current paper, see J. Nielson, 'Improved Managerial Processes for Farmers', *Journal of Farm Economics*, Vol. 43, No. 5 (December, 1961), pp. 1250-1261.

[22] G. L. Johnson *et al.*, *A Study of Managerial Processes of Midwestern Farmers* (Ames: The Iowa State University Press, 1961), pp. 145-147.

fires' variety. At the other end of the scale, good managers tend to be more systematic in the keeping and studying of records and accounts. This helps them to foresee problems and opportunities and to plan to meet them.

The classroom teaching of record-keeping, farm accounting and account analysis is often difficult and dry. Games offer an excellent opportunity to enliven these aspects of formal farm management education. The dynamic nature of the game, the involvement and the competitive element, should all engender an interest and a desire to come to grips with records and accounts provided as part of the exercise.

3. *The observation and isolation of relevant information*

This is closely related to the previous point. In the real world the farm manager may frequently suffer from 'information dazzle', a state of mind in which he is being bombarded with so much information that he becomes completely incapable of isolating the relevant from the irrelevant, and the reliable from the unreliable. On the basis that one must crawl before one walks, to play a management game in which the participant receives information to process and use or discard as he sees fit, should help prevent information dazzle at a later stage. The quantity of data and observations encountered in the game will be considerably less than in real life. Nevertheless, the experience gained in how to deal with it should provide confidence, and encourage orderly procedures of thought, and develop a positive attitude to information, all of which are conducive to better management.

There are, of course, strict limits to the realism of observational experience in a game. No game or any other formal instructional method can do much to develop the powers of observation required for the successful day-to-day operation of a farm. The ability to observe livestock and crops, to detect the need for attention and to provide the correct remedy for the situation on a day-to-day basis is critical to the success of a farm operation. There is still a great deal of truth in the old proverb—'The eye of the master fattens the beast'.

4. *Decision-making*

The specification and analysis of alternatives, together with the choice of a course of action, receive most of the attention in formal management courses. One of the major objectives of farm management education is to equip people with the analytical tools to make better decisions. The implicit assumption is that good decision-makers are successful managers. However, there is an enormous gap between classroom applications of these analytical and choice procedures, and real world decision problems. To the practical farm operator, the traditional formal course in farm management is almost as remote as a lecture series on nuclear physics. At the same time the management of a real farm must seem equally remote to the farm management student.

The major focus of both academic courses and practical farm management is decision-making, but the gap between theory and practice has arisen because there are two distinct approaches to decision-making. The first—the heuristic approach—dominates the thought processes of the real world operator, while the second—the analytical approach—occupies pride of place in farm management courses.

The heuristic approach: The well known but as yet improperly understood method of heuristic thinking includes trial-and-error probing, breaking the problem down into sub-problems (some or all of which can be solved by rule-of-thumb), and satisficing.[23] One essential feature of most real world decisions is that time spacing allows for feedback about initial actions (including no action) before final action must be taken. There is a constant monitoring of past actions with view to future decisions. The more such monitoring an individual has been able to participate in, the greater his 'experience'.

This is the most basic form of education. As Cowan points out,[24] 'All life is an experiment' generating experience which in turn may be used to influence the experiment of life, so that the organism becomes better adapted to its surroundings. Man has been able to adapt much better than most other creatures because he has developed higher forms of education which short-circuit the slow trial-and-error accumulation of experience.[25]

The analytical approach: The essential feature of this approach is that the choice is viewed as a once-over decision made after enumerating the possible action-outcome pairs. The choice of which action-outcome pair to create is made with a view to the optimization, or at least the sub-optimization, of some magnitude.

The method of making the decision consistent with this objective may involve:

(a) non-algorithmic examination of alternatives (e.g. budgeting);
(b) algorithms (e.g. linear programming by the simplex method); or
(c) mathematics (e.g. production functions and marginal analysis).

To view the decision-maker as one who is trying to select the optimal course of action from all possible actions is unrealistic for two reasons. First, it is not clear what managers want to optimize. Second, except in the most trivial cases, it is not possible to enumerate or even broadly specify all the alternatives facing the manager.

In answer to the question of what is to be optimized, some would suggest utility. However, the concept of utility is of little value as yet, since suitable operational means of measuring it in real world applications have not been developed. In most cases it is far more difficult to construct an acceptable procedure for discovering and recording utilities than it is to find a reasonably good strategy by other methods. Quite often, the uncertainty about the measure of utility is so great that it dominates any differences that may occur in choosing between available alternative action-outcome pairs.

In discussing the specification of alternatives, Churchman stresses that managers should be viewed as learners who attempt to improve their choices while faced with a continuum of uncertainty.[26] Simon and

[23] See H. A. Simon, *The New Science of Management Decision* (New York: Harper and Row, 1960), or H. A. Simon, *Models of Man* (New York: John Wiley and Sons, 1957), especially Chapter 14.

[24] T. A. Cowan, 'Experience and Experiment', *Philosophy of Science*, Vol. 26, No. 2 (April, 1959), p. 79.

[25] This may be expressed by saying man has developed greater powers of deduction. For a discussion of the relative importance of inductive and deductive reasoning in farm management see G. L. Johnson *et al., op. cit.*, pp. 65-66.

[26] C. W. Churchman, 'Decision and Value Theory', in R. L. Ackoff (ed.), *Progress in Operations Research*, Vol. I (New York: John Wiley and Son, 1961), pp. 35-64.

others have also pointed out the importance of learning and search in decision-making.[27] From the heuristic viewpoint, then, the real-life manager is a searcher, and management training should emphasize this search activity and not just the principles of optimzation. The principles and techniques of optimzation help managers to sub-optimize better. However, they need practice to see the relevance of maximizing rules which obviously cannot be applied exactly in real life.[28]

A large proportion of farmers make all management decisions by heuristic reasoning on the basis of experience. At the other extreme, many students finish farm management courses with a strong desire to analyse everything. The professional instructor may be well aware that, as Schlaifer says, 'any manager who stopped to make a formal statement of more than some very small fraction of his decision problems would clearly have no time left for managing'.[29] However, this does not help the inexperienced student or manager develop a balanced judgement about (a) *when* to use a formal method of analysis, and (b) *which* particular tool is appropriate. It is this gap which the farm management game aims to fill, because it provides an on-going simulated environment in which the participant can combine heuristic decision-making with careful analysis. He is given an opportunity to practice the art of deciding which problems warrant detailed analysis. This judgement is crucial in the successful allocation of the managerial input both in the game and in real life. The game, therefore, provides an exercise which develops the participant's facility to decide *when* and *which* tools of analysis to use as well as *how* to use them.

In this way the game provides a bridge between the two approaches to decision-making which have so often been viewed as competitive rather than complementary. This bridge can, of course, be used for two way traffic. Not only can students get the feel of 'practical' management, but also, farm operators can be introduced to analytical methods by playing the game.

5. *Taking action and bearing the consequences*

The best decisions are useless until implemented, and events which occur during implementation may require considerable modification of the original plan of action. This dynamic feature of practical management is extremely important, and games seem to provide the only feasible way of introducing it into a formal course. In a farm management game, the participant may be given some idea of the problems of implementation of a carefully prepared plan in the face of market and climatic uncertainties. As a result farm management students may develop a more understanding and balanced attitude towards the reluctance of farmers to accept and implement detailed and carefully researched farm plans.

The fortitude necessary to accept the unfavourable as well as the favourable outcome of managerial decisions cannot be developed by education. The desire to avoid unfavourable results which is a major

[27] This is emphasized in both the references cited in footnote 23.

[28] C. Hitch and R. C. McKean, 'Suboptimization in Operations Problems', in J. F. McCloskey and F. N. Trefethen (ed.), *Operations Research for Management*, Vol. I (Baltimore: The Johns Hopkins Press, 1954), pp. 168-186.

[29] R. Schlaifer, 'Decision Theory and Management Theory', in H. Koontz (ed.), *Towards a Unified Theory of Management* (New York: McGraw-Hill, 1964), p. 69.

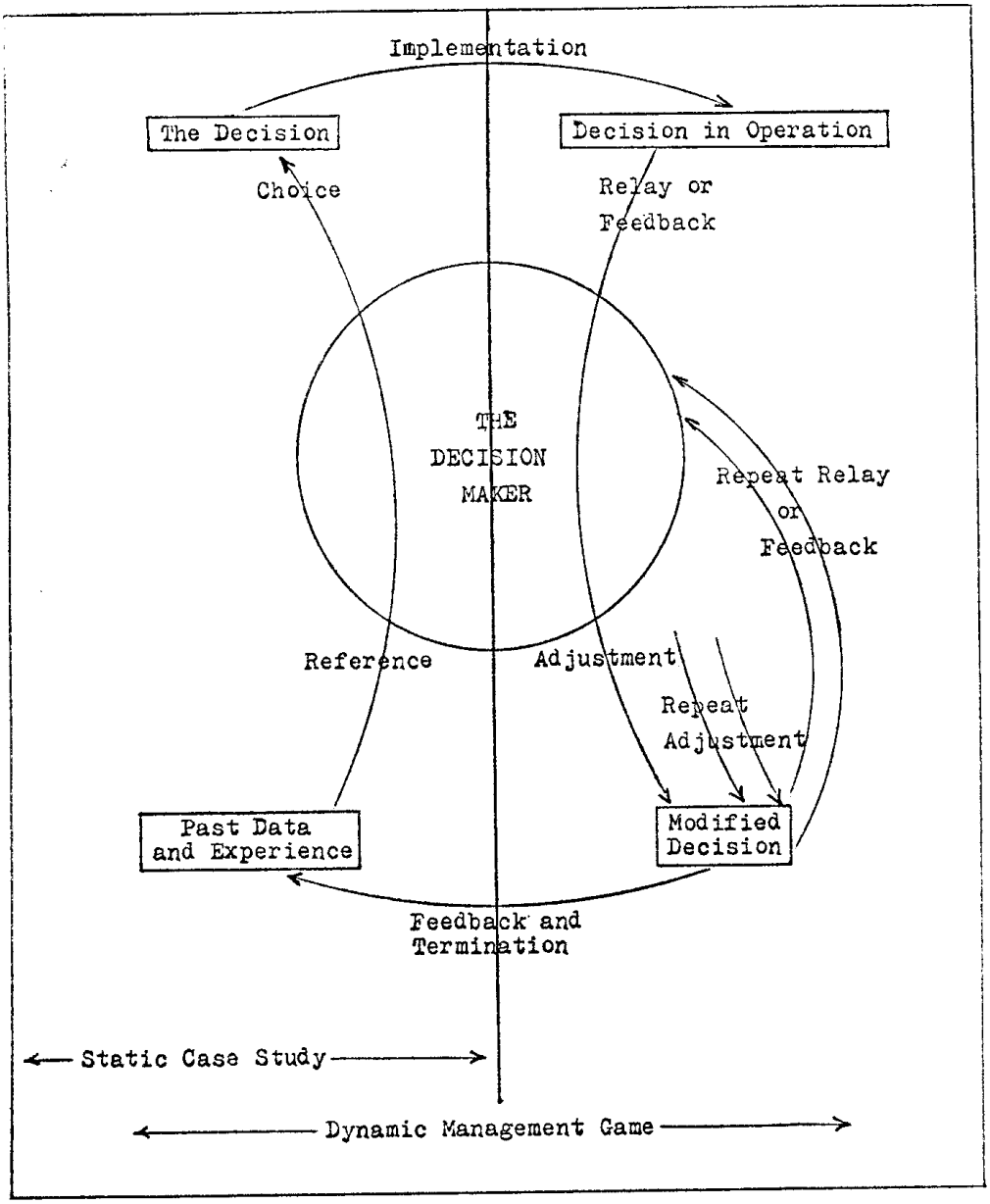

FIG. 1—The Managerial Process.

motivational force for the real life manager, is paralleled to a degree by the game competition. This may engender an attitude of seriousness and conscientiousness towards the game which is frequently entirely lacking in other farm management exercises.

Conclusion: A Game is a Dynamic Case Study

The essentially dynamic exercise provided by a farm management game is an extension of the farm case study. The traditional procedure has been to require students to study a particular farm and construct a detailed farm plan. But here the exercise stops. Past data and experience

have been collected, organized and analysed, and a broad course of action has been decided upon after carefully estimating the outcome of this, and presumably, alternative courses of action. While such cases are worthwhile exercises, they represent only part of the managerial process. This idea can be emphasized by reference to Figure 1. Games enable the student to experience the whole decision process. He must not only isolate the problem, review alternative remedies and select one, but he must also follow his plan through time and assimilate the feedback and bear the consequences of his choice.

An important contribution of gaming to the student's education is to provide experience in accepting and using this feedback in a dynamic 'on-going' environment. In this way the students are given a chance to practise learning from experience as they will be called upon to do in real life. At least one article has described this as teaching the unteachable.[30] In fact, the game can be viewed as a research experience in self discovery, rather than as an imitation of management experience.

[30] A. A. Kuehn and R. L. Day, *op. cit.*, p. 237.