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Business Games: A Simulation Technique

by John Whedon Acer

Information Series No. 3

November, 1960

BUREAU OF LABOR AND MANAGEMENT
COLLEGE OF BUSINESS ADMINISTRATION
STATE UNIVERSITY OF IOWA
IOWA CITY, IOWA



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FOREWORD

The use of business games as a tool of management development has both its supporters and its detractors. The present study examines several of the major areas of controversy, after first describing the historical development, classification, and uses of business games. It concludes with an evaluation of the effectiveness of business games as a teaching technique and a prediction as to the future of such games.

Persons seeking a general familiarity with the topic of business games will find much of interest and value in this report. Some of the technical terminology will not be familiar to the general reader, but perhaps this will stir his interest in exploring the subject further. A bibliography of more than one hundred titles is appended for that purpose.

The present publication is based upon a thesis written by the author under the direction of Professor Henry H. Albers of the College of Business Administration at the State University of Iowa. The Bureau of Labor and Management gratefully acknowledges its debt to both of these gentlemen for their permission to reproduce this study as a part of its Information Series.

J. F. Culley
Director

Bureau of Labor and Management
State University of Iowa
Iowa City

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CHAPTER I

INTRODUCTION TO THE BACKGROUND OF BUSINESS GAMES

This thesis is concerned with the nature and significance of business games. Many firms¹ and universities are now employing this recently devised technique for managerial development purposes. Business games are simplified mathematical abstractions of a situation related to the business world. The game participants, either individually or in groups, manage a whole firm or an aspect of it, by making business decisions for successive periods.

ORIGIN OF BUSINESS GAMES

Business games are an outgrowth of war games, which in turn can be traced back to the origin of chess.² "The origin of chess is doubtful but is usually ascribed to India, where it appeared as a Hindu battle game called Chaturango."³ From chess, John P. Young traces the development of war chess, modified by Weikmann (1644), Helwig (1780), Vinturini (1797), and Giacommetti (1801), and then the Kriegsspiel of von Reisswitz, Sr. (1811) and von Reisswitz, Jr. (1824). While von Reisswitz and his son continued much of the inflexibility of chess, they made progressive changes, such as substituting a scaled terrain modeled in sand on a table for the chessboard of the past. They also formulated many rules, based on statistical studies of the Napoleonic Wars and of the Prussian army, concerning such things as the rates of march, effectiveness of different types of weapons fire, and fatigue. Finally, they enlarged the role of Helwig's game director so that their umpire not only conducted the game, but had the additional duty of keeping the play realistic. Therefore, to keep the Kriegsspiel running effectively, their umpire had to be an intelligent, respected senior officer.

The von Reisswitz game required so much knowledge and time to play that a modified game, the Free Kriegsspiel, was introduced in 1873 by Meckel. Free Kriegsspiel was less standardized and required less time because the umpire's judgment replaced the pages of rules and tables of the old Kriegsspiel. The original Kriegsspiel, continued as Rigid Kriegsspiel under the work of von Tschischwitz (1862) and others, fell into disuse until recently, when the Theory of Games caused a revival of interest, and high speed electronic computation made it possible to handle a large amount of detail.

From the revived and improved Rigid Kriegsspiel, the RAND Corporation developed in 1955 a war game called Monopologs, focused upon United States Air Force logistics and requiring "... its players to act as inventory managers in a simplified simulation of the Air Force supply system."⁴ The Air Force considers Monopologs to be a very successful training device. The success of this game has been an important factor encouraging the development of the idea of business decision games.^{5, 6}

The two early business games, the American Management Association and the McKinsey versions, were written by people who were familiar with modern war games. Richard Bellman, one of the authors of the AMA simulation, was employed by the RAND Corporation and was familiar with the United States Air Force war games and logistic simulations. In addition, the authors of the AMA game visited the Naval War College, Newport, Rhode Island, to learn "... the concept of military games..."⁷ George Andlinger, co-author of the McKinsey game, worked on army war games⁸ before he started his game in 1956 "with the idea of applying war-gaming techniques to business."⁹

Many people have followed up these original business simulations with modifications or novel games of their own. Today it is possible to obtain numerous different versions, each with its own peculiarities and claims.

BUSINESS GAMES AND THE FIELD OF PROFESSIONAL EDUCATION

Where do business games fit into the field of professional education, and what

advantages do they have to offer? Basic to all professional education are certain skills, and participation techniques. The skills group includes not only such fundamental knowledge as vocabulary, but also business tools, such as accounting, operations research, and statistics. Some skills, accounting or language, for example, are fairly commonplace, whereas others which are more specialized, such as operations research, are infrequently found. All of these skills, however, function to help the individual to perform his task more efficiently. The participation techniques, the patterns of which are defined by the nature of the activity, can be grouped into indirect participation techniques, and controlled participation techniques. The former can be illustrated by attending lectures and training courses. The methods of indirect participation include reading, listening, and observing. While these methods of obtaining information are informal ones, the other type of participation technique, controlled participation, uses methods which are formal and specific. The abstractions clearly delineate the situation to be investigated. Military war games, scientific experiments, case study, and role-playing are all examples of ways in which this technique is used by professional people. Professional business education has primarily been concerned with the latter two: case study and role-playing. The case method is well-known from its usage at the Harvard School of Business Administration. When used to illustrate principles, case studies represent efficient, effective, and interesting instruments. This inductive technique is used for testing, as well as illustration.

In the other method in the area of controlled participation, role-playing, an individual is presented with a task to be performed or a role to be played in a problem situation.¹⁰ By using J. L. Moreno's "Psychodrama," psychologists have extended role-playing to testing.¹¹ Like the case method, role-playing is employed to simulate experience in the business world, but while the case method is static,¹² role-playing brings a dynamic element to the experience. Since the results of role-playing depend in part upon what the participants do, the participants are forced to adapt to changing situations.

Business games represent an advance in business simulation techniques, because they combine the principles illustrated by case study, the dynamic character of role-playing, and the new element of feedback. What are the differences between business gaming and the two other controlled participation techniques? The case method calls for a single set of decisions, while gaming uses successive sets of decisions, to place the participants in a situation which is partly of their own making (inventory accumulation or lowered profits, for example), but which can be altered by experimentation with alternative strategies and tactics. Business gaming "... differs from role-playing chiefly in its use of rigid rules, enforced by an umpire, and its emphasis on quantitative, material problems rather than on human relationships."¹³ Business gaming is the logical extension of case study and role-playing into a new form of controlled participation.

RELATIONSHIP OF BUSINESS GAMES TO MODELS

Business games are also known as simulations, abstractions, operational games and models. These terms, all of which refer to designs or representations, will be used synonymously here. However, the term model, which covers a complex area of types of representations, needs to be discussed in detail, in order to provide sufficient background in the development of gaming, and to clear the confusion which has existed among several types of representations.

There are three basic types of models:^{14, 15} iconic, analogous, and symbolic. The first type, iconic, usually is a scaled static representation, such as a photograph, model ship, or map, whose properties are identical to a real object. An analogue "... represents one set of properties by another set of properties."¹⁶ A flow chart, showing the route of materials, orders, or paper work through a factory or office, is an example

of this type, as is the weather map, whose isotherm lines show points of equal temperature at a given time. Symbolic models,^{17, 18} usually mathematical in nature, are the bases for simulation techniques. The Theory of Games, operations research, and operational games are all examples of symbolic models; however, there has been some confusion among these three related but distinct areas. The Theory of Games,^{19, 20} which was developed by John von Neumann and Oskar Morgenstern,²¹ deals with the minimax principle, which indicates the proper strategy for maximizing one's gains, or minimizing one's losses (finding the optimum solution). Gaming theory²² is competitive decision-making in the face of uncertainty with the opposition making rational decisions. It is usually considered to be an area in the field of operations research, which is really a group of techniques, usually mathematical, for marshalling information and solving for the most profitable, efficient, or inexpensive solution.²³ Linear programming, input-output analysis, and replacement theory, as well as gaming theory, are separate categories of operations research. Operational gaming, in contrast, is concerned with simulating, and making decisions in the context of the simulation.^{24, 25} These games can be designed so that gaming theory or operations research can be utilized in playing or analyzing the game, in order to obtain better results.^{26, 27, 28} Business games are those operational games related to a business framework for business purposes. Other operational games are war games²⁹ and psychological games.³⁰

A simplified mathematical model of business simulation techniques is difficult to construct, because the goals of a firm can vary over such a wide range, for example, high price, low volume, largest share of the market, a specific return on capital, or maintenance of control of the firm. However, the same general mathematical symbolic model for game theory and operations research is also applicable to business games. $E = f(X_i, Y_j)$. Let E represent the goal or goals of the firm, while X_i stands for all the factors which the firm can control, such as price, marketing expenditure, and production. Then Y_j is the expression for all the factors which the firm cannot regulate: competitors' actions, chance occurrences, action of the administrator,³¹ and characteristics of the business model itself. Thus the goal is a function of what the firm can regulate, as well as what is beyond its control.

NATURE OF BUSINESS GAMES

Business games are like any other simulation of a complex structure. Only the most relevant points of concern are abstracted, since added details so inflate the amount and time of computation.

To play a business game, the participants must first study and analyze the game information which is available to them, then synthesize this information, their previous experience, their goals in playing the game, and the group interaction (if any). The effects of their decisions in managing a business situation are calculated, either manually or by computer. This process of making calculations and comparing the results with certain objectives--feedback--combined with dynamic action, produces a situation in which planning is vital, for a team must make, in about ten to twenty minutes, the decisions for a business quarter. Inconsistency is penalized in most games, and the effects of sudden policy changes are blunted by time delays incorporated into the game. These time delays can represent the ordering and installing of new equipment, filling the channels of distribution, or initiating a new advertising campaign. Another complexity brought into gaming by feedback is that there usually is a time lag between making a decision, and obtaining the results;³² the effect of advertising, or additional productive capacity. All of these factors, which feedback contributes to business simulation, combine to place a high premium on planning, along with consistent policies. Business games, of course, cannot incorporate the unpredictable human element--novel solutions or innovations which originate from imaginative and fortunate ideas--unless this is incorporated in random payoffs on such things as research and development or

marketing expenditures.

Changes can be made in the mathematical model of a game. This is done by substituting different values for constants in equations, or by changing rules.³³ The manipulative quality of business games gives a great deal of importance, potentially, at least, to the administrator or umpire. The administration of a game can be completely controlled by either a person, or a computer, or a combination of both. The usual method in the complex games seems to be control by an individual, assisted by a computer.

ROLE OF THE ADMINISTRATOR

The administrator has a heavy responsibility in the success or failure of a gaming session, because his knowledge, ability, and planning are determinants in the total benefits to and enthusiasm of the participants. Psychologists point out that observation and retention increase with interest, and the players must remain interested, forgetting external stimuli, whether over a few long continuous sessions, or many short ones. It is the administrator's responsibility to place people on teams so that all are of equal status, or are in their actual positions in the business hierarchy.³⁴ With people of different status, the hierarchy must be maintained in order to avoid an unnatural and tense situation, unless forming a hierarchy is designated as a part of the game. The administrator must be familiar with the abstraction itself as well as with the direction of it; this enables him to modify early errors which might allow one team to outstrip its opponents, helps him to answer questions more appropriately, and allows him to guide the game with minimum of friction and a maximum of observation, learning, and understanding. The administrator must also be able to prepare and deliver an interesting and informative critique. The critique is the most important part of the game, since this is where a synthesis is presented of that model's content, the actual game play, the participants' views, actions, and goals, and any insight gained from the play. The role of the administrator includes these important responsibilities of holding the interest of the participants, effectively conducting the briefing session and the game play, and revealing in his critique what the abstraction illustrated.³⁵

METHODS OF COMPUTATION

Feedback is made possible by various methods of computation. Some games are designed so that the calculations are simple enough to do manually--by use of pencil and paper, slide rule,³⁶ or desk calculator.³⁷ Tables and charts may be used in some of these less complex games as a substitute for computations. However, electronic computers, usually the IBM 650, are used by most of the well-known business games.³⁸ But computers are not essential, and, in fact, there is a growing number of noncomputer games.³⁹ These games are usually more limited in scope than those played with the aid of a computer, but have the advantage of being less expensive to run,⁴⁰ as well as not being limited to situations where computers are available.

The computer plays an important role in the majority of present-day business games, because it offers these advantages: complicated but quick calculations, small likelihood of error, and legible presentation of results. The decisions of each game period are plugged into equations, which are based on the game designer's basic assumptions concerning such factors as research and development, production, advertising, sales promotion, and elasticities of demand, price, supply, and marketing. These games are usually set in an economic framework of oligopoly. Since, in these mathematical models, there is no difference among companies in the quality of leadership, production and product improvement, knowledge, or talent that a dollar can buy, the problem is one of putting the proper number of dollars into a given area, such as research and development or marketing, or a project such as a new product or extension of sales training. These games are intricate compared with noncomputer games, but the calculation period between sets of decisions usually should be kept under five minutes,⁴¹ to eliminate delays which would slow up game play too much for continuous

sessions. The computer can make these calculations quickly and accurately, and the printer⁴² used with the computer does a precise, rapid, and neat job of making the results available. Therefore, computers are used, when ample funds are available, in the more complex games in which time and accuracy are critical.

SCOPE AND CONTENT OF THESIS

The scope of this thesis includes the presentation of a broad background in the business gaming techniques now in use, so that the methods in this field and the direction of their progress may be explained. The uses for which business games are presently suited will be discussed, as well as the ideas of businessmen and academicians about these simulation techniques.

Chapter II classifies business games according to type, and defines, describes, analyzes, and evaluates each group. Chapter III shows the applications of these types of simulations, to illustrate how some models or particular types of models may be used. The views and comments of academicians, game designers, participants, and executives are analyzed and evaluated in Chapter IV, to present the varied ideas concerning these mathematical techniques. Finally, Chapter V presents the conclusions about the application and potential of business gaming, and investigates the future possibilities of this particular business simulation technique.

FOOTNOTES

1. General Electric Company, Kroger Company, Dayton Rubber Company, Westinghouse Electric Corporation, International Business Machines, Procter & Gamble Company, Pillsbury Company, Boeing Airplane Company, Imperial Oil Ltd., and American Management Association comprise a partial but representative list.
2. "Most sources agree ^{a, b, c} that the war game has evolved from the ancient game of chess."
John P. Young, A Survey of Historical Developments in War Games, (Bethesda, Maryland: Operations Research Office, The Johns Hopkins University, August 5, 1959).
^aC. A. L. Totten, 1st Lt., 4th U.S. Artillery, Strategos, American Games of War, (New York: D. Appleton and Co., 1880-1895).
^bE. A. Raymond, Lt., Field Artillery Reserve, and Harry W. Beer, Jr., Ph. D., "History of War Games," Reserve Officer, Oct. and Nov., 1938.
^cFarrand Sayre, Maj., U.S. Army, Instructor, Dept. of Military Art, Army Service Schools, Map Maneuvers and Tactical Rides, (Springfield, Massachusetts: Springfield Printing and Binding Co., 1908, 1910, 1911).
3. Ibid.
4. James R. Jackson, "Learning from Experience in Business Decision Games," California Management Review, Vol. I, No. 2, Winter, 1959.
5. Ibid.
6. While Monopoly -- "Parker Brothers Real Estate Trading Game" -- and other business-fun games like Finance and Fortune, Easy Money, and Careers are well-known, they do not appear to be a part of the development of business gaming. These fun games seem more closely related to war chess, with their game boards, highly stylized tactics, structured rules and procedures, and use of dice. As Andlinger points out, business games are concerned with learning rather than entertainment, are more realistic, and their results depend on experience, judgment, and skill, more than fortune.
G. R. Andlinger, "Business Games -- Play One!" Harvard Business Review, Vol. XXXVI, No. 2, March-April 1958, p. 117.
7. Elizabeth Marting, ed., Top Management Decision Simulation, (New York: American Management Association, Inc., 1957), p. 9.
8. "In This Issue," Harvard Business Review, Vol. XXXVI, No. 2, March-April, 1958, p. 12.
9. Andlinger, op. cit., p. 117.
10. Delbert C. Miller and William H. Form, Industrial Sociology, (New York: Harper & Brothers, 1951), p. 48.
11. Ibid., p. 418.
12. Professor William R. Dill notes that the new Harvard Business School policy cases are becoming slightly dynamic. "Management Games in Graduate and Undergraduate Education," prepared for the Symposium on Management Games at the University of Kansas, December 12 and 13, 1958.
13. "In Business Education, the Game's the Thing," Business Week, 1560, July 25, 1959. p. 58.
14. "A model is a miniature of, or compact representation of, an original. Usually models represent relevant points of interest in the original; these points can be combined so that the structures of the model and that of the original are similar. A set of rules may be included with a model to tell how it operates or how it can be manipulated.
"The structures and points of interest used for a given model will change as the structure and points of interest in the original change."
C. West Churchman, Russel L. Ackoff, and E. Leonard Arnoff, Introduction to Operations Research, (New York: John Wiley & Sons, Inc., 1959), p. 72.
15. A set of assumptions, definitions, and conclusions may be combined to form "... a model, because it provides a simplified and idealized image of certain aspects of economic activity."
D. W. Bushaw, and R. W. Clower, Introduction to Mathematical Economics, (Homewood, Illinois: Richard D. Irwin, 1957), p. 4 (See also the following paragraph on p. 5).

16. Churchman et al., op. cit., p. 160.
17. Robert M. Thrall, C. H. Coombs, and R. L. Davis, *Decision Processes*, (New York: John Wiley & Sons, Inc., 1954), pp. 20-26. Notice especially the diagram showing the real world transformed by abstraction into a mathematical system, which in turn is changed by mathematical argument into mathematical conclusions which are transformed by interpretation to physical conclusions.
18. "This theory does not try to describe how a game should be played. It is concerned with the procedure and principles by which plays should be selected. It is, in effect, a decision theory applicable to competitive situations." Churchman, et al., op. cit., p. 520.
19. "In this historical context, game*, is a technical term denoting a simulation in which the results for one group depend on the actions of their competitors -- a situation that is obviously desirable for management training, but almost impossible to obtain in any other classroom technique."

*"This technique has practically nothing to do with the well known mathematical theory of games, which is an attempt to formulate a mathematical theory of decision making in situations in which the outcome of a decision also depends on the course of action chosen by one or more competitors."

E. W. Martin, Jr., "Teaching Executives via Simulation," Business Horizons, Summer, 1959, p. 101.

20. Most game theory to date has been in the area of two person zero sum games. These represent single-firm monopoly or duopoly situations. Neither of these alternatives is of particular interest to businessmen or others who are concerned with the majority of business problems. N-person zero sum and non-zero sum games (especially the latter) offer much more to the business world, but they have not yet been developed to a satisfactory state.

A mathematical symbolic model for the Theory of Games could be the same model Churchman and others describe for operations research. See footnote 23. $E = f(X_i, Y_j)$ where E is the maximum gain of or minimum loss to X and is a function of all the variables X controls, which are represented by X_i , and all the variables X cannot control such as opponents' actions or chance, which are represented by Y_j .

21. John von Neumann, and Oskar Morgenstern, Theory of Games and Economic Behavior, (2nd edition, Princeton, N.J.: Princeton University Press, 1947).
22. The Theory of Games. "Gaming" refers to operational gaming.
23. "Briefly, the role of the symbolic model in O. R. can itself be described by the use of symbols as follows: Let E represent the measure of effectiveness to be used. Let X_i represent the aspects of the system (variables) which can be controlled by management decision, and let Y_j represent the uncontrollable aspects of the system. Then, in model construction, we attempt to formulate one or more equations of the form

$$E = f(X_i, Y_j)$$

The extraction of a solution from such a model consists of determining those values of the control variables X_i for which the measure of effectiveness is maximized." (Also see the paragraph preceding this quotation.) Churchman et al., op. cit., p. 162.

24. "A business game can be defined as a set of rules that corresponds to the economics of a business as realistically as possible, within the limitations of a game structure. This type of gaming, which can aptly be called 'operational gaming,' has no relation to 'game theory,' which is a theoretical approach to the solution of conflict situations. Operational gaming is essentially simulation and thus provides a framework for making trial-and-error decisions rather than for evolving an optimum strategy." Andlinger, op. cit., p. 115.
25. "Operational gaming is most often confused with game theory. Hoggatt says, 'The single most important difference between our model and the usual models of game theory is that the pay-offs to each firm (profits) are not known to the other firms. In game theory the payoff is in utility units for each player and all players are assumed to know the utility functions of each player. Since our players (and this is generally true with business games) know little about the outcomes for individual firms other than their own, it is difficult to know what the theory of games has to say about such situations.' A simple way to state the difference is to say that game theory is a branch of mathematics whereas I think that operational gaming may turn out to be a part of experimental social psychology. Game theorists simplify the environment and the number and complexity of alternatives by making arbitrary assumptions concerning human behavior. Operational gaming, on the other hand, tries, by simulation of complex environments, to put people into realistic situations in order to derive what assumptions to make about human behavior. Gaming theory is a theory of human behavior, why people do what they do in competitive situations while game theory, in an over simplified sense, is a

guide to how to win (or, more properly, how to neither win nor lose) in simple games. Eventually, these two ways of looking at similar phenomena may join but right now, I agree with Hoggatt--it is difficult to know how these theories are related."

John L. Kennedy, "Gaming Theory and its Relations to Industrial Psychology," speech made to the 1959 annual meeting of the American Psychological Association.

26. Jay R. Greene and Roger L. Sisson, Dynamic Management Decision Games, (New York: John Wiley & Sons, Inc., 1959), pp. 3-4.
27. The Market Negotiation Management Game of Greene and Sisson is an example of where the bidding model of O. R. could be used.
28. The Monte Carlo technique and a queuing model are both incorporated in United State Air Force logistic simulations.

Murray A. Geisler, Integration of Modelling and Simulation in Organizational Studies, P-1634, (Santa Monica, California: The RAND Corporation, March 11, 1959), pp. 11-12.

29. War games are presently being used by the United States Army, Navy, and Air Force.
30. Psychological games may have a business framework, but their objective is usually the study of small group behavior. Professor John L. Kennedy is doing such work at Princeton University.
31. The administrator conducts the gaming session. Frequently he has the opportunity to vary the mathematical model at his own discretion. For example, he might wish to increase price sensitivity and to decrease the importance of marketing.
32. In some games, like the General Electric Marketing Strategy Simulation Exercise II, decisions are made three quarters in advance on the basis of information available four quarters ~~before the decision takes place.~~ See Table I.
33. For example the cost of an additional unit of capacity in the IBM game can be raised from \$20 to \$50.
34. Cyert, Dearborn, Dill, Kuehn, Miller, Tonge, Van Wormer, Winters, The C. I. T. Management Game, (Pittsburgh, Pennsylvania: Graduate School of Industrial Administration, Carnegie Institute of Technology, 1959), p. A-11.
35. The Procter and Gamble inventory game in "In Business Education, the Game's the Thing," pp. 56 and 57, does not need an administrator or umpire. Most solitaire (non-interacting, individual) games which usually deal with some phase of production or storage are similar.
36. Industrial Sales Management Game by Greene and Sisson.
37. Games like the IBM one can be computed on a desk calculator in half an hour. Errors are much more likely with a desk calculator than a computer.
38. AMA, IBM, Pillsbury, UCLA, CIT, Indiana, Washington.

TABLE 1

MARKETING STRATEGY SIMULATION EXERCISE II

	Market Development of Market A (3 periods in advance)	Market Development of Market B (3 periods in advance)	Market Development of Market C (3 periods in advance)
Price of X (1 period in advance) Product Development of X (2 periods in advance)	1	2	3
Price of Y (1 period in advance) Product Development of Y (2 periods in advance)	4	5	6

(Notice that the marketing development, A, affects both areas 1 and 4, and the price of product development, X, affects areas 1, 2, and 3. Thus it is difficult to understand and control each separate product market simultaneously, since others are also involved.)

39. Andlinger, Zoll, Greene & Slason, and Greenlaw are some of the authors of noncomputer games. As Martin points out, Andlinger uses a simplified "...Monte Carlo model for computational complexities..." E. W. Martin, Jr., op. cit., p. 107.
40. Computers like the medium-sized IBM 650 Electronic Data Processing unit rent for \$60 per hour or more without operating personnel.
41. That would equal half an hour working with a desk calculator, with some likelihood of human error. "In Business Education, the Game's the Thing," op. cit., p. 58.
Noncomputer games take 10 or even 45 minutes to calculate.
42. IBM 402 or 407 with the 650.

CHAPTER II

INTRODUCTION TO THE CLASSIFICATION OF BUSINESS GAMES

The first two business games, the American Management Association and the McKinsey simulations, were begun in 1956. The following year business games were brought to public attention¹ when the AMA introduced its first game in its new Executive Decision-Making Course, the substance of which was advertised to be "... a guided investigation of the decision-making function itself."² Because of the wide-spread interest which was sparked by this game, a rash of similar general management games appeared as others hurried to explore the possibilities of this device.³ All of these models required the use of an electronic computer, but in 1958 the McKinsey game, a noncomputer simulation, was published. Given the opportunity to purchase this game,⁴ a larger segment of the public was able to participate in gaming.

The use of the gaming technique has been expanding rapidly as many companies have developed training games, and numerous business schools⁵ have worked on their own games, incorporating some into their courses. These games can be described and classified by using the following definitions and groupings.

GENERAL OR SPECIFIC

Whether a particular game is general or specific depends upon the level at which the abstraction is played, and whether or not the product or service concerned is explicitly defined. General games revolve around top management decision-making: the actions of the board of directors, the chief executive officer, and the vice-presidents. The basic problems in this type are policy-making, and allocation of funds. The goals determined by each company may vary from volume-price policies to a specific share of the market or return on invested capital. These goals influence the allocation of funds among the different business functions. If a team decides to increase its expenditures in a particular area, it must then decide where to obtain the necessary funds: from allocations in other areas (and if so, which area?), or by borrowing. These general models can illustrate either a capital⁶ or consumer⁷ goods industry.

In 1959 games began to appear which were designed to provide more insight into specific areas. These specific simulations deal with a particular industry, such as the supermarket,⁸ or replacement tire⁹ industry, or with a particular function, such as marketing¹⁰ or production. A model constructed around a specific industry (the packaged detergent¹¹ industry, for example) contains most of the features of general games, as well as some of the particularities of the industry being simulated. The games which are centered around a specific function can deal with either a clearly defined product or service, or with an imaginary or symbolic one -- "widgets."

INTERACTING OR NON-INTERACTING

Like the two early business games, most of the models which have so far been developed are interacting. Interacting means that the decisions made by one team also influence the results of all the other teams. Since the size of a total market usually depends in part on either the lowest price or the average price charged, and a particular firm's share of that market on the ratio of that firm's price to the average price charged in the market,¹² a team's change in price varies the number of units the market will absorb, thus affecting the competitors' sales by altering each company's share of the market. Carnegie Institute of Technology is considering the development of a game in which the competition itself is simulated by the model, and controlled by either the design of the game, the umpire, or both.

A few games are not interacting. In this type of simulation, the action of one team has no effect on another team, though competition is still possible through the comparison of results. Such comparisons show differences in individual team action

only, as each team strives to obtain the lowest costs,¹³ highest profits, or whatever is the game's objective.

INDIVIDUAL OR GROUP

Frequently non-interacting simulations are also individual, or, in other words, can be classified as solitaire games. In the individual game, one person can do all the work for a single team. "Usually they involve some aspect of production management such as production scheduling,¹⁴ inventory control,¹⁵ or machine loading,"¹⁶ As in non-interactive abstractions, performance is measured on a best score criteria, or in comparison with established norms.

An individual game can be converted to a group model simply by assigning more than one player to each team. Group games can be divided into two categories. One is the informal group which determines its own hierarchy,¹⁷ and the second is the formally structured group. In the latter type, the administrator not only decides who will play on each team, but also what position in the hierarchy each participant will hold. The players' instruction manual usually defines each position and describes its breadth.¹⁸ The umpire can designate any game as formal or informal, to suit different purposes.

COMPUTER OR NONCOMPUTER

Computer games are calculated automatically on an electronic computer, while noncomputer games are calculated manually, with pencil and paper, or a slide rule, for instance. Computer games can be more complex than ones in which the calculations are done by hand, but noncomputer games are less expensive to run, do not require scheduling to reserve computer time, and need not be played in a location which has ready access to a computer.^{19, 20}

UMPIRED OR SELF-UMPIRED

The function of the administrator, or umpire, is to direct the briefing, play, and critique.²¹ During the game play, the umpire may change some of the constants in the equations of the mathematical model, to reflect inflation-deflation cycles,²² variations in the elasticity of the demand curve,²³ or changes in the efficiency of marketing²⁴ or research and development expenditures.²⁵

Most games require an administrator.²⁶ The few games which are self-umpired are usually individual and non-interacting, also. In these games the player himself must perform the function of the umpire.

SIMPLE OR COMPLEX

The classification of a game as simple or complex is more subjective than the previously mentioned divisions. In the simple category are those games which try to simulate general or functional situations, without going into much detail. Most simple games can be handled by four or fewer participants, requiring a maximum decision-making period of half an hour. These participants do not need detailed knowledge of a specific industry or firm in order to play the game. Neither do they need special skills, such as linear programming. The only background required for the simple business games is a knowledge of general management principles.

Those few games which are intended to be realistic, broad in scope, and detailed, must be complex in nature. A complex game might represent a two or three-firm-dominated industry, or a thorough study of a particular firm or function. The problems in such simulations might include stock, bond, or bank financing, or even noise in the channels of communication between management and its sources of production and marketing information.²⁷

Another type of complex simulation is that which deals with specialized analysis requiring the use of special business tools, such as engineering, operations research,

CLASSIFICATION OF BUSINESS GAMES

Business games may be classified with the aid of these six categories--general or specific (an industry or function), interacting or non-interacting, individual or group (formal or informal), computer or noncomputer, simple or complex, and umpired or self-umpired.

These simulations comprise many varied combinations of the characteristics described by these categories. For example, the IBM game is general, interacting, group organized (informal), computer processed, umpired, and simple. In contrast, the CIT⁴ simulation (while it is also interacting, group organized, computer processed, and umpired) is usually formally organized, and complex. Another illustration is the Procter and Gamble inventory game which is specific, non-interacting, individual, manually processed, self-umpired, and simple. There are a few models which are specific in both the functional and industrial sense like the Dayton Tire Simulation, an abstraction of the marketing of tires by a small firm.

Using the framework outlined in this chapter, the following table illustrates the use of these categories to describe many well-known games.

TABLE 2
CLASSIFICATION OF BUSINESS GAMES

GAME	AUTHOR	General	Specific	Function	Industry	Interacting	Non-interacting	Individual	Group	Formal	Informal	Computer	Noncomputer	Simple	Complex	Unplayed	Self-Used
Air Defense Simulations	RAND Corporation			x	x	x				x			x		x	x	
AMA (Top Management Decision Game)	Bellman, Clark, Craft, Malcolm, Ricciardi	x				x				x		x		x		x	
Baselogs	Gainen, Levine, McGlothlin			x	x	x		x					x	x ¹		x	
CIT	Cyert, et al. ²				x	x				x		x			x	x	
Dayton Tire Simulation	Greenlaw			x	x	x					x		x	x		x	
Executive Action Simulation (Huston)	Herron	x				x				x			x	x		x	
Executive Action Simulation (Gilding)	Herron	x				x				x			x	x		x	
Experimental (Oligopoly) Game	Hoggatt	x				x		x					x	x		x	
IBM (Management Decision-Making Model I)	Hunter	x				x				x	x		x			x	

¹Might use operations research

²Cyert, Dearborn, Dill, Kuehn, Miller, Tonge, Van Wormer, Winters

TABLE 2 CONTINUED

GAME	AUTHOR	General Specific	Function	Industry	Interacting	Non-Interacting Individual	Group	Formal	Informal	Computer	Noncomputer	Simple	Complex	Umpired	Self-Umpired
Indiana (Executive Decision Simulation)	Martin	x			x				x		x			x	
Industrial Sales M. G. ³	Greene, Sisson		x		x	x					x	x		x	
Kroger Supermarket Decision Simulation	Greenlaw				x	x			x		x	x		x	
LP-I	Enke, Geisler, Haythorn		x	x		x		x		x				x	x
Management Decision Simulation	Martin	x ⁴			x				x		x	x		x	
Market Negotiation M. G.	Greene, Sisson	x			x	x					x	x ⁵		x	
Market Strategy Simulation Exercise II	Feeney		x		x				x	x			x		x
Materials Inventory M. G.	Greene, Sisson		x			x	x				x			x ⁶	x
McKinsey (Business M. G.)	Andlinger, Greene	x			x	x					x	x		x	

³Management Game⁴Somewhat oriented to finance.⁵Might use bidding theory.⁶Should use Economic Order Quantity.

TABLE 2 CONTINUED

GAME	AUTHOR	General	Specific	Function	Industry	Interacting	Non-Interacting	Individual	Group	Formal	Informal	Computer	Noncomputer	Simple	Complex	Unplayed	Self-Unplayed
Monopologs	Rehkop			x	x	x		x					x	x		x	
Operation Feedback	Zoll			x			x	x					x	x			x
Operation Interlock	Zoll	x				x					x		x	x		x	
Operation Suburbia	Zoll	x				x					x		x	x			x
Personnel Assignment M. G.	Greene, Sisson			x			x	x					x		x ⁷	x	
Pillsbury	Quirk, Hurwicz	x				x					x	x		x		x	
Production Scheduling M. G.	Greene, Sisson			x			x	x					x		x ⁸	x	
P. & G. ⁹ Production Scheduling Game	Industrial Engineering Division					x	x	x					x	x			x
Retailing Department M. G.	Greene, Sisson			x			x	x					x	x		x	
SOBIG	Kennedy					x	x				x		x	x		x	

⁷Should use linear programming.

⁸Should use Gantt Chart.

⁹Procter & Gamble.

TABLE 2 CONTINUED

GAME	AUTHOR	General Specific	Function	Industry	Interacting	Non-Interacting	Individual	Group	Formal	Informal	Computer	Noncomputer	Simple	Complex	Unplied	Self-Unplied
SMART I	Lubin & Others		x			x				x	x		x			x
UCLA II ¹⁰	Jackson & Others	x			x					x	x		x			x
Top Operating M. G.	Greene, Sisson	x			x		x					x	x			x
UCLA Inventory Control	Jackson & Others		x			x	x					x	x ¹¹			x
Washington	Schrieber	x			x					x	x		x			x

¹⁰"Game III is similar, except that the market has several strata, which react differently to different products because of different elasticities (re price, marketing quality)." James R. Jackson, letter dated March 15, 1960.

¹¹Might use operations research.

FOOTNOTES

1. Many articles popularizing the AMA game were written by the game designers and others: Bellman, Clark, Craft, Malcolm, and Ricciardi, "On the Construction of a Multi-Stage, Multi-Person Business Game," Operations Research, Vol. 5, No. 4, August, 1957, pp. 469-503.
Franc M. Ricciardi, "Business War Games for Executives: A New Concept in Management Training," Management Review, May, 1957, pp. 45-56.
"Learning Can Be Fun--Even for Busy Executives," Business Week, May 4, 1957, pp. 164-170.
Joel M. Kibbee, "Dress Rehearsal for Decision-Making," Management Review, February, 1959.
2. Executive Decision-Making Course flyer, American Management Association, New York, 1957, p. 1.
3. IBM Modal I, UCLA I, Pillsbury, and Washington games.
4. Send one dollar to Department A2, Readers' Service, Harvard Business Review, Soldiers Field Station, Boston 63, Massachusetts.
5. Carnegie Institute of Technology, Indiana, Michigan State, Pennsylvania, UCLA, and Washington use business games in some of their courses.
6. McKinsey game.
7. AMA and IBM games.
8. Kroger game.
9. Dayton Tire Simulation.
10. General Electric Marketing Strategy Simulation Exercise II.
11. CIT game.
12. Truman Hunter, "IBM Management Decision-Making Laboratory, Model I, Administrator's Reference Manual," New York, International Business Machines Corporation, October, 1957, pp. 18-19.
13. Procter & Gamble and UCLA inventory games.
14. Procter & Gamble game.
15. UCLA inventory game.
16. "In Business Education, the Game's the Thing," op. cit., p. 58.
17. The IBM game is specified as informal, as are the games at Princeton University (SOBIG game, for example). The majority of games are formally organized, in order to avoid status problems when executives are participants. Also, formal organization allows students, in particular, to turn their full attention from the beginning of the game to solving the problem, and eliminates the probable handicap of working under a weak organization. Cyert, et al., op. cit., p. A-11.
18. See the CIT game manual for a detailed explanation of what the positions entail.
19. Truman Hunter said that he had great success running sessions in which the teams communicated with the calculations group by telephone to give their decisions and receive their statements or results.
20. For more complete information, see the computations section of Chapter I.
21. The IBM game instructions illustrate this point. Truman Hunter, op. cit., Section 1.
22. In the IBM game this can be done by simultaneously varying T_1 , T_2 , T_3 , and T_4 . alone is changed, the rate of business activity varies somewhat, through there is little change in price levels and time lags.
23. x_1 in IBM game.

24. p_1 , p_2 , and b_1 in IBM game.
25. g and b_3 in IBM game.
26. For more complete information on the role of the administrator, refer to the section dealing with this in Chapter I.
27. CIT game.
28. For examples, see the games by Greene & Simon in Table 2.

CHAPTER III

INTRODUCTION TO THE USES OF BUSINESS GAMES

Business gaming techniques are generally used for the following purposes: to develop skills, to conduct research, to emphasize planning, and to stimulate thinking. It is often difficult to differentiate between planning and research because planning is a method and frequently an objective of research. In addition, a clear-cut boundary cannot always be drawn between teaching and thought stimulation. This chapter deals with the purposes for which games are used.

DEVELOPING SKILLS

Professional business training is most frequently concerned with three groups of skills: organizational, decision-making, and pedagogical.

Organizational Skills. These are related to the functions of the hierarchy, both of the individuals and of the groups within it. Through role-playing, games can be used to give specialists some experience with the problems of other specialists. For example, the production, marketing, and finance personnel can exchange positions. A marketing person, acting as a production man, can have the opportunity to work with inaccurate sales forecasts, or as a finance specialist, strive to maintain a budget against the pressure of marketing and production demands. Functional games help the participants to develop an awareness of the problems and complexities of a particular area.¹ The general games are useful in orienting neophytes and specialists to an organization, and in broadening the viewpoint of operating personnel, not only by giving them the opportunity to familiarize themselves with new divisions, but also by increasing their understanding of the functioning of the managerial hierarchy. An understanding of hierarchical functions forms a basis for the development of broader organizational skills.

An important aspect of hierarchical action is systematic coordination, one of the main problems of top management. Coordination involves a clear division of effort² to prevent overlapping or underlapping, and intergration to promote a unity of purpose. This problem is emphasized in informal group simulations, in which teams (in order to play effectively) form their own hierarchy, delegate responsibilities, select relevant information, and coordinate the ideas and activities of the individual team members.³ Formally grouped games give similar experience in a situation in which the individual has less control over the hierarchical structure.

Decision-making Skills. Games may be used to develop objective and subjective decision-making skills. Subjective decision-making places reliance upon intuition or "hunch" as opposed to the objective methods of science. Business games give experience in objective decision-making, and through feedback, enable their participants to evaluate, thus giving practice in modifying and improving, their decisions. In general games, in which the basic purposes are making policy decisions and allocating capital, a team, by intelligent experimentation with funds, can analyze the relationships between marketing and research and development expenditures, pricing policy, and production volume, thus learning how to achieve its goals. These general games teach objective decision-making through experimentation, evaluation, and modification. Some game decisional problems involve situations of narrow scope without interacting effects in a firm.⁴ Problem solving is utilized in these situations; many functional games illustrate this kind of decision-making exercise.⁵ This method is frequently a sub-routine of more complicated and general games.

Pedagogical Skills. Many business games have been designed to illustrate the value of business tools, and to give practice in using them. As noted in Table II in Chapter II, some games are ideally used with specific tools, such as operations research or statistics. Other games give practice in using such business financial tools as balance sheets, income and expense statements, and statements of cash flow.⁶ Still others are used to teach students to follow such indicators as inventory level and net profit as a

per cent of sales. These tools provide information helpful in business decision-making.

General games are highly useful in introducing people to the business world and to the field of business gaming. A variety of simple general business games can be selected for this purpose. The IBM or UCLA II⁷ games are likely choices if an IBM 650 computer is available and the cost of operating it is not a deterrent. These games have the advantage of neatly typed statements prepared by the computer five to ten minutes after the decisions are collected.

Suitable noncomputer games include the McKinsey Game,⁸ Herron's games,⁹ Management Decision Simulation,¹⁰ and Top Operating Management Game. The last mentioned game is probably best suited to wide application; it is easy to administer, is not slanted toward a particular function, and does not require the use of a special tool.¹¹ These noncomputer games are especially useful for orientation purposes. Any difficulties resulting from specificities can be overcome by the effort of the administrator to explain the more complicated points.

Other general games can be used to illustrate business gaming, and to emphasize the areas of executive decision-making. Some of the more complex total enterprise simulations, when played by informed or experienced people, not only can effectively introduce gaming, but can also investigate such important points "as over or under commitment in relation to capacity, overtime problems, inventory, short and long range research, (and) management of profits."¹² Most games give the participants, whether they are executives or students, an opportunity to exercise their mental ability and to integrate knowledge acquired from both education and experience.

CONDUCTING RESEARCH

Business simulations are presently being used for research in three areas: experimental psychology, military logistics, and business.

Experimental Psychology. Making use of controlled laboratory conditions in which the subjects are deeply involved with comparatively realistic business situations¹³-- the medium of the business game-- psychologists are studying human relations,¹⁴ small group behavior,¹⁵ and human behavior in conflict situations.¹⁶ It is possible to control the experimental environment without overtly interfering or influencing the participants, and even without their being aware of such control. This method is in contrast to role-playing experiments dealing with small groups behavior at the University of Texas,¹⁷ during which experiments the staff member brings significant actions of the participants to their attention. "Operational gaming¹⁸ has the potential to make, in its business game aspect, a substantial contribution to industrial psychology."¹⁹

Military Logistics. The logistic simulations designed for the United States armed forces comprise a second group of research games. These models, in contrast to regular war games, are mainly concerned with supply and maintenance. Except for their military orientation,²⁰ they have much in common with business games. The RAND Corporation has designed several simulations for the Air Force, one of which is "a comparative study of two logistics systems supporting the same operating units,"²¹ whose purposes are "to examine a series of proposed changes to the logistic system for feasibility"²² and "compare the performance of the proposed policies with an alternative but arbitrary system called LS-1 (Logistics System 1) which was intended to simulate the 1956 Logistics System of the Air Force."²³ A second model, to be used with logistic studies, was intended to generate the failures which occur on aircraft due to the stresses of flight, age, and inspection,²⁴ to simulate the needs for repair, replacement, and maintenance. Such detailed logistic simulations are useful in research to improve the armed forces' logistic system, making possible greater efficiency and money savings.²⁵

Business. The military applications of gaming indicate possible similar uses in business research by universities and by corporations, particularly in finding cheaper

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Business. The military applications of gaming indicate possible similar uses in business research by universities and by corporations, particularly in finding cheaper

and quicker methods²⁶ in the areas of purchasing, maintenance, and scheduling.

Another significant use of gaming may develop from research in the organizational structure of firms. Through simulating the present structure of a firm and comparing its efficiency with different models, researchers may be able to find a more effective structure, and closely related to this, better policies and improved methods. Alternative plans are simulated to determine the most efficient ones. The complex CIT game is the initial publicized effort in this direction. Much similar work apparently is being carried on by corporations, but they are reluctant to discuss the matter, probably fearing that their competitors will gain information about company secrets or plans for the future.²⁷

Research in business through gaming can include research in business gaming, itself. A broader application of gaming is in modifying existing abstractions and in writing new ones. Truman Hunter, who designed, programmed, and administered the IBM game, said it was made public so that others might have the benefit of his work. He intends for people to use his model as a guide or basic building block in designing new models to investigate or illustrate other aspects of business.²⁸ Greene and Sisson emphasize this same idea for their noncomputer devices, devoting one chapter to writing games and one to modifying existing ones. Modifying a game is useful in stressing particular points, and, since such changes nullify much of the advantage gained from prior game knowledge, in placing participants on a more nearly equal starting basis.

EMPHASIZING PLANNING

Business games give emphasis to present and future planning through three methods of time variation: time compression, time lag, and time cumulation.

Time Compression. This is the amount of time which a team is allotted to make its decisions for one period. Time compression can be varied to suit the objectives of the situation: for example, an original twenty-minute time allowance²⁹ may be shortened, thus forcing a team to rely more on long-range planning. Because of team interaction, the necessity for planning is impressed upon each individual team. It behooves each firm, since the industry is usually representative of an oligopoly, to consider carefully its competitive practices, bearing in mind the fact that one or two firms might bankrupt the entire industry by embarking on certain ill-considered policies--severe price cutting, in particular. Of course, business games can graphically illustrate this point if that is desired.

Time Lag. This method of time variation can contribute greatly to the difficulty of a model, for it refers to the number of periods which elapse between the making of a decision, and the occurrence of the action based on that decision. A game becomes more demanding as time lag is increased--for instance, if facilities for increasing plant capacity must be ordered a year, rather than a quarter, in advance.³⁰

Time Cumulation. While time lag deals with the waiting periods associated with production or capacity, time cumulation deals with the residual effect of past and present product development, distribution, and public relations expenditures. This device is used in two ways. First, the amount spent for research and development, for example, may be accumulated over the successive decision-making periods. This may be either the actual sum, or one modified by a scaling factor.³¹ Second, an allocation may be divided over a number of periods, with a specified per cent for each period.³² Through either of these means planning is emphasized by stressing the momentum of past decisions.

THOUGHT STIMULATION

Stimulation is dependent upon two closely related activities: teaching, and arousing interest. Observation and retention increase with interest, as learning theorists point

out, although interest itself is increased with new understanding and insight. The dynamic nature of business games makes them excellent teaching devices.

Four specific types of games may be used for the purpose of stimulating, depending upon what other parameters should be considered. A heuristic game³³ can be used as an explanatory vehicle, to orient unfamiliar personnel, and to increase interest and understanding. This type of simulation also emphasizes dynamics, with its rapidly-moving concern with important decisions, without the delay of detail and record-keeping.³⁴ The participation type of developmental simulation,³⁵ the type used in war gaming, can be used with complicated and poorly specified problems, with the objective of bringing out ideas, and increasing understanding. The prototype or demonstration simulation,³⁶ which deals with a fairly completely structured or specified problem, can give participants the opportunity to evaluate their methods, or can produce more information for complete specification of a problem. Finally, the training simulation,³⁷ which is a part of the program used to prepare Air Defense crews, can "... control the stimulus, measure the results, and provide the trainees knowledge of their performance."³⁸ All of these types of simulations can stimulate the thinking of their participants, both through teaching and through awakening interest.

Because of feedback, games can demonstrate the changing nature of business better than any other device. These simulations present a stimulating challenge to intelligent and analytical participants, helping them to return to their positions with a new understanding of the complexity of their job or study areas, and an increased realization of the importance of informed judgment.³⁹

FOOTNOTES

1. The Proctor & Gamble Inventory Game, for example, deals with production scheduling.
2. Executive Action Simulation and the CIT game both describe the responsibilities involved in the various positions in the game hierarchy.
3. Planning is emphasized in Operation Interlock.
4. An example of problem solving is the use of operations research to resolve scheduling difficulties. On the other hand, a question of granting a five per cent increase in hourly wages is outside the scope of problem solving.
5. Inventory control or production scheduling games, for example.
6. Management Decision Simulation.
7. The UCLA II model, which is concerned with some detail (three products, overtime, cash flow, profit and loss, cyclic sales, and others) is considerably more sophisticated than the IBM model.
8. A difficulty of this game is its Monopoly aspect; time and care are required to keep the symbols in their proper squares, especially if the game is played on an interrupted schedule. Another difficulty is its use of time lags in training salesmen, in increasing capacity, in accounts receivable, and in production.
9. The Huston and Gilding games, written by Herron, both emphasize production scheduling with three plant locations, three stages of assembly, transportation concerns, and time lags. Thus these two games are especially suited for people interested in this area.
10. The lucidly written Management Decision Simulation, emphasizing the financial aspect of management and thereby appealing to a specific group, concerns problems which may be difficult for the neophyte.
11. This game allows the participants considerable flexibility in the handling of cash balances so that no bankruptcy or financing problems exist. However, the game limits the size of pricing and marketing changes which can be made between successive periods, so that radical variations in decisions are controlled.
12. Allen, A. Zoll, Business Games in Management Training at the Boeing Airplane Company, p. 1.
13. "In Business Education, the Game's the Thing," Business Week, 1560, July 25, 1959, p. 64.
14. Making decisions under stress is being investigated at Imperial Oil. Ibid., p. 64.
15. Case Institute of Technology, Carnegie Institute of Technology, and Princeton University.
16. Austin C. Hoggatt, "An Experimental Business Game," Behavioral Science, Vol. 4, No. 3, July 1959, P. 192.
17. Robert R. Blake and Jane Srygley Mouton, Training for Decision-Making in Groups, (Baton Rouge, Louisiana: Standard Oil Company of New Jersey, 1958), p. 11.
18. It is interesting to note that gaming is being used to try to train diplomats for International meetings. Graduate students who played came away fascinated with the potential of operational gaming "... as a research tool for building explicit theory." Harold Guetzkow, "A Use of Simulation in the Study of Inter-Nation Relations," Behavioral Science, Vol. 4, No. 3, July 1959, p. 190.
19. John L. Kennedy, speech to the American Psychological Association, p. 2.
20. The military framework of these games places them in the complex category.
21. This quotation refers to LP-1. William W. Haythorn, Simulation in RAND'S Logistic Systems Laboratory, P-1075, (Santa Monica, California: RAND Corporation, April 30, 1957), p. 4.
22. Murray A. Geisler, A First Experiment in Logistics System Simulation, P-1415, (Santa Monica, California: RAND Corporation, July 8, 1958, p. 2.
23. Ibid.
24. W. McGlothlin, G. C. Noonan, Jr., G. E. O'Dell, S. L. Pollack, The Simulated Aircraft and its Failure Model in LP-1, (Santa Monica, California: The RAND Corporation, May 26, 1958).
25. These simulations are expensive, but the possible savings are high in relation to the costs. The United States Air Force logistics, alone, is a multi-billion dollar a year operation.

26. Games can be devised and played by experts to experiment with various problem-solving techniques, which could actually be used by a firm after the game had accomplished the initial finding and perfecting of the methodology.
27. John Harling, "Simulation Techniques in Operations Research--A Review," Operations Research, Vol. 6, No. 3, May--June 1958, p. 313.
- John F. Lubin, Proceedings of the National Symposium on Management Games, Center for Research in Business, The University of Kansas, Lawrence, Kansas, 1959, p. V-4.
28. These statements were made in a personal interview (December 8, 1959).
29. Teams should also be able to do some of their evaluation, record keeping, and planning during the calculation time.
30. An excellent example of the use of time lag is the Marketing Simulation Exercise II. See Table I at the end of Chapter I. In contrast, most uncomplicated games, such as the IBM or AMA models, have the capacity available after a single period.
31. In the IBM game, the effective research and development figure for period n , F'_n , equals the previous period's figure F'_{n-1} times a scaling factor, g , plus the current period's actual R & D allotment, F_n .
- $$F'_n = gF'_{n-1} + F_n$$
- Truman Hunter, "IBM Management Decision-Making Laboratory, Model I, Administrator's Reference Manual," (New York: International Business Machines Corporation, October, 1957), p. 18.
32. In the IBM game, the effective marketing expenditure for period n , E'_n , equals the sum of the marketing allocation for the two previous periods, E_{n-1} and E_{n-2} , times an adjustment factor, $p_1 p_2$, plus the present period marketing allocation, E_n , times the adjustment factor p_2 . With p_1 and p_2 each equal to 0.5, half of the present allocation added to one quarter of the marketing amount of each of the two previous quarters constitute the effective marketing figure, E'_n .
- $$E'_n = (E_{n-1} + E_{n-2}) p_1 p_2 + E_n p_2$$
- Ibid.
33. Baselogs, and Procter & Gamble or UCLA inventory games.
34. W. H. McGlothlin, The Simulation Laboratory as a Developmental Tool, P-1454, (Santa Monica, California: RAND Corporation, August 7, 1958), p. 2.
35. The other type of developmental simulation--observational--is familiar to psychologists as the administrator observes with the object of learning how people react to stress, learn, and make decisions.
36. The prototype simulation is mainly a research and development vehicle.
37. Any of the business games which require a special tool like operations research. See Table 2.
38. W. H. McGlothlin, op. cit., p. 7. The ideas in the previous paragraph come from ibid., pp. 2-7.
39. Informed judgment rests on an intelligent appraisal of all the pertinent facts which are available.

CHAPTER IV

INTRODUCTION TO THE CONTROVERSY ON BUSINESS GAMES

There has been much controversy concerning business games since their inception, and particularly since their wider introduction to practical affairs. Some people, perhaps because of lack of knowledge or imagination, have belittled gaming.¹ Many of these recently have modified their views and are approaching agreement with the moderates, who have conservative but hopeful expectations for the future. The more extreme enthusiasts believe that gaming will soon become the major method of educating people in business concepts, and performing specific managerial tasks, such as evaluating personnel. Since business gaming is a comparatively new technique, such attitudes cannot be reinforced by conclusive evidence. But the ideas and experience of people who are close to this field can add to present knowledge and awareness of future possibilities. This chapter will describe and analyze some of the views of people who are prominent in the field of gaming.

AREAS OF CONTROVERSY CONCERNING BUSINESS GAMES

The main areas of controversy include: teaching potential, insight into business and planning, training in decision-making, application of game conclusions, and emotional involvement and stimulation.

Teaching Potential. Most people agree that business games offer great teaching potential to the business and academic worlds, but they disagree on what it does or can teach. Some emphasize that proof of teaching value is still lacking.² Professor James R. Jackson has commented, "Those who have worked with games in educational contexts generally seem to have felt that they were of some use, myself included, but often promote their points of view without much regard for the rules of evidence (I'm included here, too)."³

Professor Fred Kniffin believes that business games are poor for teaching facts, in contrast to the case method, which is fair, and lectures, which are good. However, he stated that business games may be useful for teaching facts, when more information about firms and industries is available. In this connection, student players might make a study of a particular industry before playing a specific game.⁴

Business games are useful in teaching skills and theoretical concepts like marginal analysis, Professor Kniffin points out. They are also of use in problems solving, though most of the learning comes from the critique, in which students are asked why they did or did not do certain things during the game play. Such questioning brings out the areas stressed in the design and administration of the game.⁵

Truman Hunter, who wrote, programmed, and administered the IBM game, thinks of this game as an educational experience. It can be used to orient trainees, broaden specialists, and study group behavior. He warned gamesters to pay attention to the general qualitative aspect of the model rather than the quantitative (planning for a profit), which is incidental.⁶

Professor Jackson believes that games may be used to help overcome what he considers the major weakness of business schools and particularly operations analysis courses--bridging the gap between theory and practice. The UCLA III simulation deals with problems too complicated to be treated as entities and too closely interrelated to be investigated individually. These problems are empirical, yet embrace the analysis and synthesis of concepts. The empirical difficulties include intelligent competitive behavior, risk-taking, uncertainty, and innovation. Preliminary results with this game have been highly encouraging.⁷

It seems possible for a business game, in a well designed framework, to teach facts, methods, and concepts. If the case method is successful in teaching management criteria, gaming should similarly be successful. Some people believe that gaming may

replace the case method,⁸ but these individuals are forgetting the administrative advantages of the latter--they can be performed individually, can easily be obtained at low cost, cover more problem areas, lend themselves to stylized solutions, and are easier to use in a classroom. If business games could overcome their practical disadvantages, they might, because of feedback and time variations, be a better teaching device than case studies.

Insight Into Business and Planning. Dr. Paul S. Greenlaw feels that business games probably provoke greater insight into the actual business world, "particularly since the individual is forced to cope with a dynamic process in which many different yet inter-related aspects must be considered."⁹ However, a middle management man, after participating in a business game, felt that the designers and administrators were not presenting business as it really is.

Gaming is not as realistic as an Electronic Flight Simulator which "...not only reproduces all of the aircraft characteristics but also provides training in the operation of aircraft weapons and responses to problems encountered in actual warfare."¹⁰ Games are simplifications designed to focus attention on the points of particular interest to the designers, and to provide greater insight into these problems. A small addition to the complexity of a game usually adds a disproportionate amount of calculations. However, some models deal with such complicated problems as intra-firm inefficiencies, personal relationships, and unequal effectiveness of expenditures.

Personal relationships and intra-firm inefficiencies are brought out through informal groupings. Inefficiencies are also incorporated by giving the participants incorrect information: economic forecasts, costs, and productivity.¹¹ Most games take into account the unequal effectiveness of dollars spent by one firm by reducing the returns to scale¹² for the purpose of pointing up marginal analysis. However, this does not bring out the varying efficiencies of the expenditure of one firm compared with another firm. This concept is simulated by a Monte Carlo¹³ method in one game.¹⁴ A random numbers table is used with the cumulative amount¹⁵ spent on research and development to determine when a firm makes a product improvement. In another game¹⁶ there are three areas of uncertainty: when a new product is discovered, which of ten possible products it is, and what characteristics the product has. A small allocation might result in a very good product and a large one in no product at all.¹⁷ Chance can be included in simulations to help remedy the equality of expenditures problem. "...The qualitative results of how, when, where, and with what skill, determines success or failure in business--not merely how much..."¹⁸

The amount of insight into actual situations provided by gaming depends upon the inclusiveness of the simplification and the quality of the components of the session. Professor Jackson comments that games, whether they do or do not teach much about business, give "...experience in learning from experience..."¹⁹ Players can practice planning and coordination as long as they are familiar with the games rules, such as the time variations. Different parameters in the abstraction (for example, if the time lag between deciding to increase production capacity and having the additional capacity available is two years instead of one quarter)²⁰ do not thwart the learning of concepts, unless a game is designed to familiarize the participants with a particular industry or firm. Also, transfer of game experience to reality is usually desirable only when the gaming purpose is specific, like the teaching of methods.

Training in Decision-making. The American Management Association stated that its Executive Decision-making Course (which consists essentially of its business game) is "a training method which effectively reproduces the years of practice and experience which create executive ability in decision-making."²¹ Since this initial, enthusiastic publicity²² (generally considered to be exaggerated), most people in the field are accepting the more conservative claim made for the IBM model. "Its purpose is to give participants experience in making decisions similar to those made by executives in top

management positions."²³

Dr. Greenlaw feels that "games do give an individual an opportunity to see and analyze the consequences of his own actions" thus forcing him to attempt" to foresee all possible consequences of a particular decision or series of interrelated decisions--much more so than most other teaching tools."²⁴ Dr. Kniffin believes that business games are far superior to anything else for training in decision-making, particularly to the case method in which there is no sequential feedback.²⁵

A criticism voiced on this subject is that the executive's faculty of decision-making will be impaired by gaming,²⁶ since he is accustomed to using the subjective method. The executive is confused and hampered in his job after experience in making objective decisions in a business game. These views, if not totally incorrect, are at least short-sighted. Business games provide training in decision-making methods based on the analysis of facts. The decisions themselves are not important, as the briefing and debriefing periods should stress. How can the search for, and analysis of, facts constitute a hindrance to executive decision-making?

Application of Game Conclusions. "Few businessmen," G. R. Andlinger has written, "would apply any specific conclusions from a game to reality without some appraisal of its suitability."²⁷ Dr. Greenlaw qualifies Andlinger's statement in this way: "Although perhaps the 'ideal' executive may not attempt to apply specific conclusions to reality, many of our 'not-so-ideal' executives might just do that. However, this danger probably exists in the use of many other training tools to the same extent that it might in gaming."²⁸ Professor E. W. Martin, Jr. adds that "students who have had no realistic experience" may make erroneous applications.²⁹

Professor Jackson stresses the importance of briefing and debriefing in discouraging thoughtless application of game conclusion.³⁰ This point is also emphasized by Dr. Greenlaw: "... more attention should probably be placed by the instructor or game administrator upon just what the game is intended to teach, what are its limitations, etc. in the session."³¹

A limitation of business gaming concerns the gaming assumptions, or "intrinsic economic relationships."³² The relationships written into the Pillsbury game, which follow the basic teachings of microeconomics, are representative of most gaming assumptions.³³ However, as Dr. George J. Feeney points out, "the market... responds to decisions on the basis of a set of relationships that were derived from general assumptions of market behavior rather than the specific structure of some particular market." He believes that participants "should be cautioned to disregard almost entirely the specific relationships that may be encountered in the exercise since they may have no validity at all in a particular real situation."³⁴

The problem of unsuitable application of game conclusions can be alleviated by thorough briefing and debriefing. This places a great deal of importance on the administrator's knowledge, foresight, and thoroughness. Proper selection of participants may help in some cases. Another aid might be in integrating simulations with other professional educational skills and participation techniques, into thoughtfully designed programs which have specific goals.³⁵

Emotional Involvement and Stimulation. An article about gaming stated that game participants "... argue hotly over policy decisions--sometimes even come to blows. This strong emotional involvement is what makes business gaming such a powerful teaching tool."³⁶ This statement prompted the following reaction from Dr. Greenlaw: "There is certainly considerable involvement in most gaming sessions, and consequently considerable interest. There is a possibility, however, that some individuals may become too involved in the game (and especially on winning), that they become more interested in the results than in learning about the decision-making process, and that real learning be rather insignificant as a result."³⁷ A similar opinion, expressed by Professor Jackson, was that "emotional involvement leads to poetry, ulcers, and the use of alcohol

to excess," not too often to "intellectual concentration." Professor Jackson added that "whenever I've felt that a game was turning into a significantly emotional experience, I've also felt that it was turning into a farce."³⁸

Strong emotional involvement is not usually desirable in business gaming because it interferes with an objective approach to the simulated problem. This contrasts with field maneuvers, a training method which is considered inadequate because of lack of emotional involvement. The purpose of field maneuvers is to prepare soldiers for combat, but these maneuvers lack the most essential elements of realism: fear, for example.³⁹ Business games are not intended to be copies of actual situations, but devices for demonstrating concepts. Because of the basic competitive structure of business, emotional involvement cannot be completely avoided. This involvement ideally should be manifested as an interest in, or stimulation toward, learning. The administrator can help in controlling the competitive energies of the players and directing them toward the purpose of the game, not toward ascendancy over another player or team.

FOOTNOTES

1. "Russell H. Hassler, associate dean of Harvard Business School, calls gaming 'a very useful technique' but doubts that it will replace the case method. He says he can't quite visualize students 'playing games all day long.'" "In Business Education, the Game's the Thing," Business Week, 1560, July 25, 1959, p. 63.
2. Professor John L. Kennedy, chairman of the Department of Psychology, Princeton University, believes that the teaching value of business gaming is yet to be proved. Since the learning processes are part of the realm of psychological research, it is logical that the teaching potential of gaming will need final evaluation by psychologists.

Dr. Paul S. Greenlaw, Director of Management Development at the Dayton Rubber Co., has noted that gaming, up to now, has been mainly the work of mathematicians and operations researchers. He believes that more educators and social psychologists should try to find out "... just what kinds of learning do take place." (Letter, March 11, 1960).
3. Professor Jackson is director of the Western Management Science Institute, Graduate School of Business Administration, University of California, Los Angeles.

Letter, March 15, 1960.
4. Professor Kniffin is a member of the Department of Marketing at Pennsylvania State University, State College, Pennsylvania.

These ideas, based on a paper he presented to the American Marketing Association meeting in Washington, D. C. on December 29, 1959, was given in a telephone interview.
5. Ibid.
6. Mr. Hunter's views were presented in a personal interview on December 8, 1959.
7. John F. Lubin, Proceedings of the National Symposium on Management Games, (Lawrence, Kansas: Center for Research in Business, The University of Kansas, 1959), p. 1-9.
8. "In Business Education, the Game's the Thing," op. cit., p. 63.
9. Letter, March 11, 1960.
10. Curtiss-Wright Corporation, 1959 Annual Report, p. 12.
11. The economic forecasts for future business activity are not always reliable. For example, in Management Decision Stimulation, the players are warned that the long-range prediction is not as accurate as the ones for the following period. E. W. Martin, Explanation for Participants, 1960, p. 14.
12. This point is illustrated by reducing the effect (sales magnitude index value) per page of advertising in the Gilding game from 0.30 for a single page to 0.22 for five or more pages. Lowell W. Herron, Executive Action Simulation, (Englewood, New Jersey: Prentice-Hall, Inc., 1960), p. 68. The above figures were calculated from data on that page.
13. "The Monte Carlo technique... consists of using random sampling to play a game with nature of a man-made system in which an experience is simulated." C. West Churchman, Russell L. Achoff, and E. Leonard Arnoff, Introduction to Operations Research, (New York: John Wiley & Sons, Inc., 1959), p. 175.
14. McKinsey game.
15. A team's accumulation starts from zero after each product improvement is granted.
16. CIT game.
17. Peter R. Winters, Proceedings of the National Symposium on Management Games, op. cit., p. 1-9.
18. Allen A. Zoll, Business Games in Management Training at the Boeing Airplane Company, p. 3.
19. "In Business Education, the Game's the Thing," op. cit., p. 63.
20. IBM and many other games.
21. AMA flyer for Executive Decision-making Course, p. 4.
22. Developing its game cost the AMA between \$50,000 and \$100,000, a large investment to amortize. However, in 1959 it had to cancel its two week course built around that game due to a lack of registrations accord-

- ing to Mr. Harold B. Schmidhauser, Director, General Management Courses, AMA, in a telephone interview on December 8, 1959. Apparently games had become commonplace enough by then that the \$1000 course was not competitive. The AMA now has a new approach with a four-week simulation course emphasizing planning, organization, and review or controls. The final week is spent playing games.
23. Truman Hunter, "Management Decision-making Laboratory, Participants' Instructions, IBM Model I," IBM Corporation, New York, 1957, p. 1.
 24. Letter, March 11, 1960.
 25. Telephone interview, Ibid.
 26. Karl Goldschmidt, "Comments on Business Games," Operations Research, Vol. 6, No. 1, January-February 1959, p. 124.
 27. G. R. Andlinger, "Looking Around--What Can Business Games Do?" Harvard Business Review, Vol. 36, No. 4, July-August 1958, p. 156.
 28. Letter, March 11, 1960.
 29. Prof. Martin is Associate Professor of Business Administration at Indiana University School of Business, Bloomington, Indiana. He has written the Indiana and the Management Decision Simulation games. This opinion was expressed in a letter, April 14, 1960.
 30. Letter, March 15, 1960.
 31. Letter, March 11, 1960.
 32. Oliver B. Schenk, "Mathematical Models of Market Simulation," Journal of Marketing, Vol. 24, No. 4, April 1960, p. 71.
 33. See Ibid. for a description of the assumptions used in the Pillsbury game.
 34. Dr. Feeney is with the Marketing Services Research Service, General Electric Company. He is the author of their marketing strategy series. This quotation is from Marketing Strategy Simulation Exercise II, participants' manual, General Electric Company, p. 1-2.
 35. "In Business Education, the Game's the Thing," op. cit., p. 64.
 36. Ibid., p. 63.
 37. Letter, March 11, 1960.
 38. Letter, March 15, 1960.
 39. S. L. A. Marshall, Men Against Fire, (Washington, D.C.: Combat Forces Press, and New York: William Morrow and Company, 1947), p. 71.

CHAPTER V

This chapter presents a summary and the conclusions about business games, discusses the aptness of the term, relates them to a technique of proven value, and projects their uses into the future.

SUMMARY AND CONCLUSIONS

Business games are controlled participation techniques for professional education. They combine the case method, role-playing, and feedback, to simulate dynamic experience in the business world. These symbolic mathematical models incorporate relevant points of concern in a framework based on certain economic assumptions of the designer. The game play consists of analyzing and synthesizing information, making decisions concerning a business situation, and evaluating and modifying these decisions on the basis of calculated results.

Industrial firms and business schools have developed many games, which can be grouped according to these classifications: general or specific, interacting or non-interacting, individual or group, computer or noncomputer, umpired or self-umpired, and simple or complex. These simulations, which comprise many varied combinations of these characteristics, are used for developing skills, conducting research, emphasizing planning, and stimulating thinking. The skills with which gaming is concerned are organizational, decision-making, and pedagogical. The areas of research include experimental psychology, military logistics, and business. The usefulness of business gaming is controversial, but there are strong indications that it has a great deal of potential in teaching facts, methods, and concepts, can provide insight into business and planning, and can train in decision-making. Another area of controversy concerns the application of game conclusions. Direct transfer of game experience is desired only when the game's purpose is to present specific information. In other games, the briefing and debriefing by the administrator must emphasize that the situation is a simplification of the business world, to prevent the forming of misconceptions by the participants and to minimize thoughtless transfer of game conclusions. Overuse of games might also cause misconceptions. There is always some emotional involvement in gaming, which adds interest and stimulation, but this can and should be directed toward learning rather than competing.

APTNESS OF THE TERM

Business gaming is the best designation for this part of operational gaming (which, in turn, is a branch of operations research). Since this name is widely accepted, its continued use will avoid a controversy like the one involving cybernetics and information theory. The word business is superior to names like management or executive because it is broad enough to include both general and specific abstractions. Management (which includes decision-making down to the foreman's level) and executive are more properly applied to total enterprise simulations, not to games in which the object is providing practice in using tools. Game is preferred to terms like simulation, abstraction, model, exercise, and action because it denotes a contest with stated rules, while the terms do not bring out this competitive aspect; their stress is on the simplification of business concepts. Von Neumann and Morgenstern use the word game to stress competition and rules,¹ in spite of the confusion which exists between gaming and the Theory of Games. Game also underscores the enjoyable and interesting side of this technique, an aspect which helps in the achievement of its serious purpose--professional competency, effectiveness, and efficiency. This term, which is adopted from war games, acts as a constant reminder that the technique differs from reality.

VALUE INFERRED FROM WAR GAMES

War games have proved to be useful substitutes for experience since the King's Game, written by Christopher Weikmann over three hundred years ago.² They were widely used in the Nineteenth Century, and have been used even more frequently in the Twentieth; the Germans employed them to substitute for field maneuvers and tactical rides in the Twenties and Thirties,³ and to prepare for the invasions of France⁴ and the Soviet Union;⁵ the Japanese used them to work out the details of Pearl Harbor;⁶ and the United States Armed Forces has used them for many varied purposes since World War II.⁷ Business games are the direct descendant of, and are similar to, war games. Similarities include competition, rules, and assumptions (economic vs. military). Though time is needed to improve the quality and prove the value of gaming, it is reasonable to assume that business gaming will achieve success in training students and businessmen parallel to that attained by war games in training officers.

THE FUTURE OF BUSINESS GAMES

Improvements and developments in business gaming can be made in several areas. The possibilities of computer games will be enlarged by advances in the computer themselves. The reliability of these electronic calculators will most likely be improved by further developments related to semi-conductors and plug-in units, which developments will also decrease the cost, size, and power requirements of computers.⁸ The development of the idea of micro-miniaturization (making components so small they are measured in atom diameters instead of inches) would make feasible computers with billions of memory units and several calculating units, able to incorporate the logical capacity of a man's brain.⁹ Simultaneous advances in heuristic problem solving like those envisioned by Simon and Newell¹⁰ are possible if breakthroughs are accomplished in computer logic programs and languages.¹¹ Such breakthroughs should make it possible to test and determine theories, policies, and decisions for functions, firms, or industries.¹² Perhaps program libraries of "models of the component subsystems of the firm will be developed corresponding to the characteristics of various industries, markets, and worker populations"¹³ to have the building blocks for synthesizing a specific system to simulate a particular firm or industry.

Through similar advances in electronic data processing,¹⁴ cybernetics, psychology, and communications, and extended use of statistics, operations research, and accounting, the management of tomorrow will be equipped to recentralize, and to replace some bottom and middle management personnel with mathematical models programmed on the computers.¹⁵ The trend will be toward more management by exception, centralization, and decision-making based on informed judgment.

This trend will create new problems as it solves some of the old ones. The hierarchy will be more impersonal, and less opportunity will exist for those in middle management to gain experience to prepare for advancement. Business games can be used to compensate for this lack of experience in exercising responsibility. At the top management level, games can be used for planning and experimenting, thus aiding in making decisions and stating policy with a greater certainty of the results.

Noncomputer games will continue to deal with situations in which there is not a huge mass of detail. They may overtake and surpass the case method in usefulness, since they have the dynamic advantages of gaming, yet are low in cost, high in mobility, and fairly easy to construct. They will continue to be used in many heuristic and developmental situations which do not require a computer. Their heuristic purposes are to increase interest, improve training, and teach difficult concepts.

The possible use of business games to select, evaluate, and test executives and potential managers is probably the farthest in the future. After increased experience in gaming and greater development of the technique, more will be known about what information games can supply, and what characteristic they can actually test. From the

psychological point of view, it appears that predictive testing is not yet consistent enough.¹⁶ Finally, executives are used to dealing with real money. How will they act with play dollars?¹⁷

The ultimate limits of business gaming will be largely controlled by the limits of computers, and their logic programs and languages. Games could become so complex that time compression in game play is lost in which case it might be preferable to work in industry, where creativity, uncertainty, and value judgments are present. Games cannot simulate the subjective elements of real situations any more than field maneuvers can simulate fear-producing components. Business games, with the aid of computers and their logic programs and languages, will be able to elicit decisions similar to those an executive would make, but not better decisions, because the value judgments incorporated into the program and model are man-made.¹⁸ The ultimate limit of business games, like real executive decision-making is dependent upon human value judgments.

FOOTNOTES

1. "The game is simply the totality of the rules which describe it." John von Neumann and Oskar Morgenstern, "Theory of Games and Economic Behavior," (Princeton, New Jersey: Princeton University Press, 2nd Edition, 1947), p. 49.
 2. John P. Young, A Survey of Historical Developments in War Games, (Bethesda, Maryland; Operations Research Office, The Johns Hopkins University, August 5, 1959), p. 7.
 3. Ibid., p. 79.
 4. Ibid., p. 84.
 5. Ibid., p. 85.
 6. Ibid., p. 87.
 7. Ibid., pp. 100-103.
 8. "Semi-conductors," Business Week, 1595, March 26, 1960, pp. 74-121.
 9. Richard P. Feynman, "The Wonders That Await a Micro-microscope," Saturday Review, April 2, 1960, p. 46.
 10. "(1) That within ten years a digital computer will be the world's chess champion, unless the rules bar it from competition.
(2) That within ten years a digital computer will discover and prove an important new mathematical theorem.
(3) That within ten years a digital computer will write music that will be accepted by critics as possessing considerable aesthetic value.
(4) That within ten years most theories in psychology will take the form of computer programs, or of qualitative statements about the characteristics of computer programs."
- Herbert A. Simon and Allen Newell, "Heuristic Problem Solving: The Next Advance in Operations Research," Operations Research, Vol. 6, No. 1, January-February 1958, pp. 7 and 8.
11. The programming of logic appears to be the major difficulty. For examples see: Paul W. Hagensick, "Computers in Behavioral Science" and Bert F. Green, Jr. "IPL-VI The Newell-Shaw-Simon Programming Language," Behavioral Science, Vol. 5, No. 1, January 1960, pp. 87-98.
 12. "Computers for heuristic problem solving will replace executives only when the costs per unit of problem-solving capacity are competitive with the costs for executives." Simon and Newell, op. cit., p. 8.
 13. Norris Asimow, Proceedings of the National Symposium on Management Games, (Lawrence, Kansas: Center for Research in Business, the University of Kansas, May 1959), p. V-3.
 14. EDP makes more information available more quickly than manual methods.
 15. Harold J. Leavitt and Thomas L. Whisler, "Management in the 1980's," Harvard Business Review, Vol. 36, No. 6, November-December, 1958, pp. 41-48.
 16. Years of experience are needed to evaluate tests like the Rorschach. William H. Whyte, Jr., The Organization Man, (Garden City, New York: Doubleday & Company, Inc., 1957), p. 210.
 17. H. K. L'Ecuyer, Proceedings of the National Symposium on Management Games, op. cit., p. IV-23.
 18. Professor Henry H. Albers makes the statement that computers can make different decisions but not better decisions. The problems of uncertainty and ethics provide the ultimate limit with respect to both human and machine decision-making.

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