University Grant Program Research Report

AN INVESTIGATION INTO THE CLIMATE FOR TECHNOLOGICAL INNOVATION IN CANADA

by

M. JAMES DUNN and BOYD M. HARNDEN
in collaboration with
P. MICHAEL MAHER

Faculty of Business Administration
and Commerce,
The University of Alberta,
May, 1974.

Rapport de recherche sur le Programme de subventions aux universités

Industry, Trade and Commerce
Office of Science and Technology
Ottawa, Canada

Industrie et Commerce
Direction des sciences et de la technologie
Ottawa, Canada

18

AN INVESTIGATION INTO THE CLIMATE FOR TECHNOLOGICAL INNOVATION IN CANADA

by

M. JAMES DUNN and BOYD M. HARNDEN
in collaboration with
P. MICHAEL MAHER

Faculty of Business Administration
and Commerce,
The University of Alberta,
May, 1974.

The views and opinions expressed in this report are those of the authors and are not necessarily endorsed by the Department of Industry, Trade and Commerce.

AN INVESTIGATION INTO THE CLIMATE FOR TECHNOLOGICAL INNOVATION IN CANADA

A Fundamental Research Effort Directed Towards The Design Of An Experimental And Management Development Program For Research And Development Project Selection Decisionmakers

by

M. James Dunn, Ph.D.

and

Boyd M. Harnden, Ph.D.

in collaboration with

P. Michael Maher, Ph.D.

The University of Alberta
Faculty of Business Administration and Commerce
Edmonton, Canada
May, 1974

This study was supported by the Department of Industry, Trade and Commerce, Ottawa, Canada

PREFACE

As noted on the title page, our respected and highly valued colleague, P. Michael Maher is listed as a collaborator with the principle authors of this report. The undersigned want to make it perfectly clear that his input, ideas, and direction contributed immensely to the product of the research effort of the past ten months. It was his initial drive, vision, and ambition that gave the project initial impetus. His physical ability, but not his quick mind, was impaired in the unfortunate October 1973 crash of his private aircraft. Although he provided important judgment and input after October, his loss was deeply felt. As might be expected, as a result of Mike's reduced capacities, the project probably took a slightly different direction than it would have under the full force of his participation and was executed in a manner over which he had no control. In addition, he might not agree with the analysis of data or some of the conclusions drawn therefrom. In order to absolve Professor Maher from any responsibility for the quality of, interpretation of data presented in, or conclusions reached during this study he is listed as a collaborator. Mike, we hope that we did not let you down.

A note of appreciation is in order for our two diligent and hard working research assistants, Dave Day and Ken Proudfoot. They carried the bulk of the responsibility for developing the

"Bibliography of Gaming and Simulation" contained in Section VIII of the report. Errors in interpretation of the literature contained in the bibliography are our own.

It should also be mentioned that we are extremely grateful to Meg Richardson, the Librarian for the Faculty of Business Administration and Commerce at the University of Alberta. She developed the search procedure which was followed in the review of the literature on management games and simulation. This was a very valuable input to the study.

Also, the secretarial staff of the Faculty of Business Administration and Commerce were extremely helpful, particularly Mrs. Adams who typed the questionnaire and Mrs. Milligan. Mrs. Milligan continually provided assistance over and above the call of duty and to her we are extremely grateful.

Finally, we want to thank that "beautiful grandmother" Diane Harnden for typing the manuscript, and Professor Mike Vertigan for editing both the rough and final draft. (The Bibliography of Gaming and Simulation contained in Section VIII is computer printed output).

April 30, 1974
The University of Alberta
Edmonton, Canada

M. James Dunn

M. James Dunn, Ph.D.
Associate Professor
Faculty of Business Administration & Commerce

Boyd M. Harnden

Boyd M. Harnden, Ph.D.
Professor
Faculty of Business Administration & Commerce

TABLE OF CONTENTS

TABLE OF CONTENTS Continued

LIST OF TABLES

LIST OF TABLES Continued

LIST OF TABLES Continued

LIST OF TABLES Continued

LIST OF TABLES Continued

SECTION I

RECOMMENDATIONS

The recommendations which follow are based primarily on conclusions drawn from the summaries contained at the end of each section of this report. Conclusions leading to the recommendations are based on a blending of information from a variety of sources. Such sources include reviews of various pertinent areas in current academic and related literature, information contained in personal letters received from management of technologically based Canadian firms, analysis of data contained in 196 usable-timely responses to a survey questionnaire which was sent to all firms known to be engaged in R & D in Canada as of the fall of 1973, a limited number of personal interviews with top management, informal conversations with various managements during the past one year, and some telephone conversations.

A. Recommendations Pertaining To The Primary Objective Of This Study: Design Requirements For An Experimental And Management Development Program For Research And Development Project Selection Decisionmakers.

1. The use of a management simulation for extending fundamental research into the "willingness of managers to adopt" more quantitative and/or

scientific approaches for decisionmaking is feasible and development of such a simulation, in the Faculty of Business Administration and Commerce, at the University of Alberta, should proceed immediately.

2. It is feasible to combine both fundamental research and management development objectives in a properly designed management simulation. Design requirements for such a simulation are listed below.

   a. The research objective of the simulation should be the extension of fundamental knowledge about a decisionmaker's "willingness to adopt" quantitative techniques.

   b. The management development objective should be to emphasize use, strengths and weaknesses, and potential operational impact of quantitative decisionmaking techniques including technological forecasting, in the area of R & D project selection.

   c. The simulation should be supported by an integration of other appropriate educational aids such as films, slides, lecture presentation, group discussions, etc.

d. The simulation itself should be short, simple, computerized and perhaps interactive.

e. In order to be computer independent, the simulation should utilize a minicomputer.

f. The simulation should emphasize the data required in order for various quantitative techniques to be useful. Difficulty and cost of obtaining any required data should be made explicit.

g. The simulation should be designed to monitor flow of data from the use of quantitative decisionmaking techniques in such a manner that the value of information derived therefrom is adequately displayed.

h. The simulation needs to be flexible horizontally (by industry, company, and government agency), and vertically (by level of management). This implies the need for a simulation with a flexible and perhaps readily adaptable modular construction.

i. The simulation environment needs to be manipulated in an unobtrusive manner so that fundamental data with respect to a decisionmaker's "willingness to adopt" quantitative decisionmaking techniques can be extracted without the knowledge of the participants in the simulation.

3. It appears that it is feasible to meet the design requirements listed above. The Department of Industry, Trade and Commerce should fund the proposal for future research, which was requested by the Department and submitted by the authors of this report in conjunction with Professor M. J. Vertigan on January 25, 1974.

B. Recommendations Pertaining To Future Policy Considerations Designed To Promote Technological Innovation In Canada.

1. Government policy, with respect to support of R & D, seems to be oriented towards production of usable end-products. One way to expedite the use of modern decisionmaking techniques might be to also subsidize R & D efforts aimed at improving or developing the required modern decisionmaking software.

2. The Department of Industry, Trade and Commerce should seriously consider subsidizing firms who wish to participate in the simulation that will be developed as a result of this research.

C. Recommendations Pertaining To A Central Agency For Coordinating Technological Forecasting Effort Taking Place Throughout Canada.

1. An inventory of various committees, organizations, research units, and university efforts in the area of technological forecasting needs to be established.

2. A method of coordination or an agency to coordinate various technological forecasting efforts, existing in Canada, needs to be established.

D. Recommendations Pertaining To Future Related Research.

1. The use of modern decisionmaking techniques, by Canadian manufacturers, needs to be delineated in greater detail.

2. An up-to-date study, providing a "new profile" of Canadian executives and middle managers, should be undertaken immediately. Available data appear to be obsolete.

3. A study aimed at making an inventory of specific areas to which Canadian managers think Canadian Business Schools might direct their research efforts, particularly applied research efforts, could be extremely illuminating and useful. Such a study should be undertaken immediately.

SECTION II

INTRODUCTION

A. Objectives Of Study

This study reports on research into the subject area "The climate for technological innovation in Canada." The primary objective of the work done from July, 1973, through April, 1974, was to lay the groundwork for the design of an experimental and management development program for research and development project selection decisionmakers.

Originally our thinking was to focus solely on the experimental portion of the objective stated above and attempt to extend the research done by Maher and others.[1,2,3,4].

---

1. Maher, P. M., "Results From An Experiment With A Computer-Based R & D Project Selection Technique," Paper presented at TIMS XIX Meeting, Houston, Texas, April 4-8, 1972.

2. Maher, Souder, et. al., "Quantitative Decision Models: Factors Influencing Adoption," Research supported by the U.S. Army Research Office and reported on in a Working Paper, Faculty of Business Administration and Commerce, December, 1972.

3. Souder, Maher, Rubenstein, et. al., "A Method For Developing Acceptable Project Selection Models," Research supported by U.S. Office of Naval Research Grants and reported on in a Working Paper, Faculty of Business Administration and Commerce, 1972.

4. Maher, P. M., and Rubenstein, A. H., "Factors Affecting Adoption Of A Quantitative Method For R & D Project Selection," Forthcoming in Management Science.

However, as background material was gathered and reviewed as part of the development of the framework for the research effort, it became apparent that there was perhaps an equal or greater need for including a management development emphasis in the research objectives. For example, in a report dated January, 1973 to the Ministry of State for Science and Technology, Ottawa, Thomas E. Clarke stated:

> "More work needs to be done in designing models or techniques which can be used by the managers of today who generally do not have a strong grounding in the use of the computer sciences in decision-making."[5]
>
> "Another area which requires attention is that of training managers in the use of more formal quantitative techniques in decisionmaking."[6]

In another report by Clarke it was pointed out that unfortunately, there were only two papers found which dealt with project selection in Canadian organizations.[7] In addition, Clarke pointed out the immediate importance of the need to evaluate the effectiveness of the present practices of different companies with the view to promoting the use of the best of these in other organizations where suitable.[8]

---

5. Clarke, Thomas, E., "Bibliography of Recent Papers Concerned With Project Selection and Evaluation," January, 1973, Report for Ministry of State for Science and Technology, p. 12.

6. Ibid., p. 13.

7. Clarke, Thomas, E., "Decisionmaking in Technologically Based Organizations: A Literature Survey of Present Practice," December 1972, Report for the Ministry of State for Science and Technology, Ottawa, p. 3.

8. Ibid., pp. 34-35.

Clarke's thinking was supported by Daly and Peterson in an article that appeared in the December, 1973 issue of Management Science which was devoted to "Management Science in Canada." Daly and Peterson pointed out that studies indicated that only in larger Canadian companies is there an adequate awareness of management science and operations research methodology.[9] Daly and Peterson state:

> "We are not aware of any evidence that managers born and bred north of the border are inherently destined to be more or less effective, but a concerted effort needs to be made by Canadian management scientists and others in a position to bring about change, to bridge the gap between the existing level of decisionmaking practice and that which is potentially possible. Otherwise, the incentives to entrepreneurs which we propose will bear little fruit. . . . . Improvement in Canadian productivity that we have discussed, cannot be achieved through fraternal meetings alone whatever their content. If we believe in our mission, we must stop hiding behind the relatively well defined boundaries of science and accept a more directly innovative role. The time for management science in Canada to change is now."[10]

Therefore, current research as reported on by the authors of this report was influenced by two major factors: (1) the lack of empirical data with respect to decisionmaking in Canadian technologically based organizations, in particular the lack of data with respect to decisionmaking in the area of project selection and evaluation, and; (2) the apparent need for a Canadian

---

9. Daly, D. J., and Peterson, R., "On Bridging the Gaps," Management Science, Vol. 20, No. 4, December, Part II, 1973, p. 564.

10. Ibid., p. 568.

management development program aimed at increasing Canadian managers' skill in the use of modern decisionmaking techniques, i.e., the use of more scientifically oriented methods for decisionmaking. It was concluded that any research oriented towards the design requirements for a series of experiments in R & D project selection had to bridge the gap between the "theoretical" and the "applied" in order to be really useful in the long-run to Canadian management. The research program which emerged is described below.

B. Research Program

The program of research conducted during the past year was organized to include the following activities.

1. Empirical data pertinent to the research objectives was gathered through the mailing of an extensive questionnaire to all companies in Canada reporting R & D activity as of the fall of 1973. Questionnaire data were analyzed using routines available in the SPSS package at the University of Alberta Computer Center.[11] Results of the analysis of the questionnaire are reported in Sections III, IV, V, VI, and VII of this report.
2. The inclusion of the management development component in the current background work led to a thorough review of the "state-of-the-art"

---

11. Nie, N. H., Bent, D. H., and Hull, C. H., Statistical Package For The Social Sciences, McGraw-Hill, Inc., 1970.

of Management Games and Simulation. This review resulted in the "Selected Bibliography of Games and Simulation" which is included and discussed in Section VIII of this report.

3. The original plan was to conduct extensive personal interviews with a broad cross section of Canadian management who responded to the questionnaire and who indicated a willingness to participate in such interviews. However, time and budget constraints, brought about by the increase in scope of the current research over and above that which was originally funded, limited this activity to a smaller than planned for scale. Canadian industrial management leaders were interviewed in order that interpretation of anomolies in the data might be improved, to solicit specific ideas with respect to the diffusion of management decisionmaking technique and knowledge from the more advanced Canadian firms to the less advanced Canadian firms, and to gain an understanding of the "climate for technological innovation in Canada" over and above that which is possible through analysis of questionnaire oriented data.
4. A summary of results of the analysis of the data obtained from the questionnaire is being sent to the management of over 200 firms who responded.

C. Questionnaire

The questionnaire which was mailed to approximately 550 different Canadian firms is shown on the next seven pages. The "climate for technological innovation in Canada" is clearly a function of many variables. The most important of these variables are government policy and programs which affect the level and direction of industrial firms' R & D activity, product markets available to Canadian firms, various attitudes of Canadian society in general (for example, attitudes towards preservation of environment and management of natural resources), country of residence of major ownership component of industrial firms, availability of a skilled management group who are able to think in more far sighted terms than those generated by immediate corporate problems, and the level of sophistication of decisionmaking in technologically based organizations. The questionnaire was primarily designed to gather basic empirical data with respect to the level of sophistication of decisionmaking in technologically based organizations. This kind of basic data is required as input before any serious long-run effort into the design of an experimental and management development program for research and development project selection decisionmakers can be undertaken. The rationale behind each major segment of the questionnaire is discussed under the appropriate section in this report. However, as one can observe, the questionnaire was designed to:

1. Provide general information about the respondents, i.e., level of management, area of market, organization of R & D effort, etc.

CLIMATE FOR TECHNOLOGICAL INNOVATION IN CANADA

SURVEY QUESTIONNAIRE

I. GENERAL INFORMATION

1. What is the official incorporated name and location of your company?

   Name of Company: _____

   Location of Company _____

2. What is your position (title) in the organization?

3. In which province(s) is your firm entitled to conduct business? Please check (√).

a) All Provinces	____	g) Quebec	____
b) British Columbia	____	h) New Brunswick	____
c) Alberta	____	i) Nova Scotia	____
d) Saskatchewan	____	j) Prince Edward Island	____
e) Manitoba	____	k) Newfoundland	____
f) Ontario	____	l) The Territories	____

4) Does your firm sell its products or services internationally? Yes____ No____

5) Would you please indicate (√) the major industrial classification(s) to which your firm belongs.

a) Agriculture	____	i) Retail Trade	____
b) Forestry	____	j) Wholesale Trade	____
c) Mining	____	k) Finance	____
d) Manufacturing	____	l) Insurance	____
e) Construction	____	m) Real Estate	____
f) Transportation	____	n) Service	
g) Communication	____	o) Public Administration	____
h) Utilities	____	p) Defense	____

6) Would you please indicate (√) whether your firm is solely engaged in Research and Development or whether Research and Development activities are part of a larger corporate structure.

   a) Solely Research and Development _____

   b) Research and Development is part of corporate structure _____

7) Please indicate (√) the way in which your Research and Development activities are organized.

   a) Pure Research and Development _____

   b) Applied Research and Development _____

   c) Mix of Pure and Applied Research and Development _____

   d) Other (would you please briefly describe below?) _____

_____

_____

_____

_____

II. PRODUCT DEVELOPMENT

Terminology used in the following section of the questionnaire

(1) Management Determination of product fields and markets of primary interest.

(2) Exploration - the search for new product ideas which meet company objectives.

(3) Screening - quick analysis to determine which ideas warrant investigation.

(4) Business Analysis - the expansion of an idea, through creative analysis, into a concrete business recommendation including product features and a program.

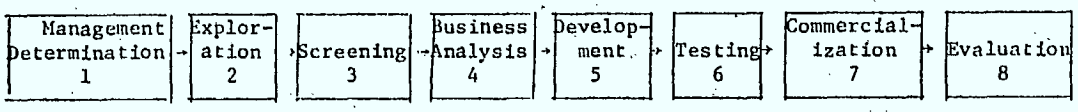
(5) Development - turning the idea-on-paper into a product-in-hand.

(6) Testing - the commercial experiments necessary to verify early business judgments.

(7) Commercialization - launching the product in full-scale production and sale.

(8) Evaluation - post introduction evaluation to determine whether to continue or drop the new product.

Schematic - the following schematic represents one possible corporate alignment of work flow for management of new products.



8. Would you please indicate (✓) at what point(s) in the above schematic marketing personnel are brought into the product innovation stream and what level of management is brought in.

Schematic Number	Marketing Personnel Brought in	Marketing Personnel Not Brought in	Level of Management Brought in: Top	Middle	Line	Other (e.g. Consultants) (please specify)
1						
2						
3						
4						
5						
6						
7						
8						

9. Would you please indicate (✓) the degree of influence marketing personnel have when they are brought into the product innovation stream.

No Influence _____ _____ _____ _____ _____ _____ _____ Total Influence

10. Would you please indicate (✓) at what point(s) in the above schematic marketing personnel should be brought into the product innovation stream and what level of management should be brought in.

Schematic Number	Marketing Personnel Should be Brought in	Marketing Personnel Not Brought in	Level of Management Should be Brought in: Top	Middle	Line	Other (e.g. Consultants) (please specify)
1						
2						
3						
4						
5						
6						
7						
8						

11. Would you please indicate (✓) the degree of influence marketing personnel should have when they are brought into the product innovation stream.

No Influence _____ _____ _____ _____ _____ _____ _____ Total Influence

III. RESEARCH AND DEVELOPMENT PROJECT SELECTION

12. Does your firm use Research and Development project selection techniques? Yes___ No___

13. Would you please indicate (√) below whether your firm is currently using, has used in the past, plans to use in the future, or has never used the following Research and Development project selection techniques.

Terminology

a) Ranking Models where the decision maker compares one project with another or a grouping of projects and selects which he prefers.

b) Scoring Models which compute an overall project score based on rating of the project against preselected critical criteria.

c) Economic Models which employ calculations such as net present value, internal rate of return, or economic equations.

d) Constrained Optimization Models which attempt to optimize an economic objective function subject to specific resource constraints.

e) Risk Analysis Models which are based on a simulation analysis of input data in distribution form.

TECHNIQUES	used for past 2 years	used for past 2-5 years	used for longer than 5 years	plan to use in future	have never used	used but discarded (Give year discarded)
a) Ranking Models						
b) Scoring Models						
c) Economic Models						
d) Constrained Optimization Models						
e) Risk Analysis Models						

14. If your firm is not using any of the above Research and Development project selection techniques would you make a brief statement as to why this is so.

_____

_____

_____

_____

15. Is your firm satisfied with its present procedures for selection of Research and Development projects?

Yes_____ No_____

16. Do present procedures used for the selection of Research and Development projects involve the use of probability estimates for technical and/or commercial success?

a) For technical success Yes_____ No_____

b) For commercial success Yes_____ No_____

17. Are specific Research and Development projects selected from multiple proposals or are they looked at one at a time?

a) From multiple proposals Yes_____ No_____

b) Looked at one at a time Yes_____ No_____

18. Please describe briefly steps taken by your firm to stimulate the generation of Research and Development and/or New Product ideas.

_____

_____

_____

_____

_____

19. What factors are used by your firm to evaluate Research and Development projects? Please check (✓).

a) Research and Development
- Likelihood of technical success ___
- Development cost ___
- Development time ___
- Capability of available skills ___
- Availability of R&D resources ___
- Availability of R&D facilities ___
- Patent status ___
- Compatibility with other projects ___

b) Manufacturing
- Capability of manufacturing product ___
- Facility and equipment requirements ___
- Availability of raw material ___
- Manufacturing safety ___

c) Corporate Objectives
- Fits into overall objectives and strategy ___
- Corporate image ___

d) Financial
- Profitability ___
- Capital investment required ___
- Annual (or unit) cost ___
- Rate of return on investment ___
- Unit price ___
- Payout period ___
- Utilization of assets, cost trend, cost reduction, and cash flow ___

e) Timing
- Timing of introduction of new product ___
- Expected product sales life ___

f) Marketing and Distribution
- Size of potential market ___
- Capability to market product ___
- Market trend and growth ___
- Customer acceptance ___
- Relationship with existing markets ___
- Market share ___
- Market risk during development period ___
- Pricing: trend, propriety problem, geographical extent, and effect on existing products ___
- Complete product line and quality improvement ___

20. Would you please indicate (✓) whether there have been changes in corporate objectives, corporate control systems, corporate structure, professional development of Research and Development personnel, and type of information in the data base during the specified time periods.

	during past 2 years	during past 2-5 years	longer than 5 years	no change
a) Changes in objectives				
- Financial				
- Production				
- Marketing				
b) Changes in corporate control systems				
- Financial				
- Production				
- Marketing				
c) Changes in corporate structure				
- More centralized structure				
- More decentralized structure				
- Moved from line-staff to a program management structure				
d) Changes in professional development opportunities for Research and Development Personnel				
- Increased opportunity for professional development				
- Decreased opportunity for professional development				
e) Changes in sources or type of information included in the data base used for the selection of Research and Development projects				
- Changes in source				
- Changes in type				

21. Given your response to question 20 above, to what degree does your firm agree with the following statements regarding the impact of the changes on the morale of Research and Development personnel and on the output of the Research and Development unit. Please check (✓).

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
a) The changes in the following areas have led to increased morale of Research and Development personnel					
- Changes in objectives	____	____	____	____	____
- Changes in corporate control systems	____	____	____	____	____
- Moved toward a more centralized structure	____	____	____	____	____
- Moved toward a more decentralized structure	____	____	____	____	____
- Moved to a program structure	____	____	____	____	____
- Increased professional development opportunity	____	____	____	____	____
- Decreased professional development opportunity	____	____	____	____	____
- Changed sources of information	____	____	____	____	____
- Changed type of information	____	____	____	____	____
b) The changes in the following areas have led to increased output from the Research and Development unit					
- Changes in objectives	____	____	____	____	____
- Changes in corporate control systems	____	____	____	____	____
- Moved toward a more centralized structure	____	____	____	____	____
- Moved toward a more decentralized structure	____	____	____	____	____
- Moved to a program structure	____	____	____	____	____
- Increased professional development opportunity	____	____	____	____	____
- Decreased professional development opportunity	____	____	____	____	____
- Changed sources of information	____	____	____	____	____
- Changed type of information	____	____	____	____	____

22. To what degree does your firm agree with the following statements? Please check (✓).

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
a) Formal decision processes help in logically consistent decisions	____	____	____	____	____
b) Formal decision processes allow research management to more clearly identify those projects or ideas which are well worth investing time and money in and those which are not	____	____	____	____	____
c) Formal decision processes allow termination of unsuccessful projects at the earliest possible time	____	____	____	____	____
d) Formal decision processes make managers aware of information that should be acquired when making decisions on projects or ideas	____	____	____	____	____
e) The primary objective of using formal decision processes is to make decisions for managers	____	____	____	____	____
f) The primary objective of using formal decision processes is to aid managers in making decisions	____	____	____	____	____

23. Who in your organization makes decisions regarding the following types of Research and Development programs?

	Person and/or group in organization
a) Exploratory Research and Development Programs	
b) High risk business development Research and Development programs	
c) Support of existing business Research and Development programs	

24. Do considerations of scientific break-throughs internal or external to your firm influence funding patterns for Research and Development activities?

Yes____ No____

25. Do you have some intuitive or operational criteria for the identification of a "good funding pattern?"

Yes_____ No_____

IV. TECHNOLOGICAL FORECASTING

26. Does your organization use technological forecasting techniques? Yes_____ No_____

27. Would you please indicate (✓) below whether your firm is currently using, has used in the past, plans to use in the future, or has never used the following techniques in connection with Research and Development selection and/or Product Development.

TECHNIQUES	used for past 2 years	used for past 2-5 years	used for longer than 5 years	plan to use in future	have never used	used but discarded (Give year discarded)
a) Extrapolative Approaches						
b) Morphological Analysis						
c) Scenario Writing						
d) Impact Analysis						
e) Relevance Analysis						
f) Contextual Mapping						
g) Normex Reconciliation						
h) Delphi Method						
i) SOON Charting						
j) Technological Mission Analysis						

28. When considering Research and Development projects does your firm consider the following questions? Please check (✓).

	Yes	No
a) Is Research and Development consistent with corporate strategy?		
b) Should we invest in the same technologies as our competition?		
c) How do we maximize the flexibility of our organization structure in the face of rapid technological change?		
d) How can technology transfer best be achieved from Research and Development to Manufacturing and Marketing?		
e) What kind of product/market strategy should we follow?		
f) What technical advantages in our products, at what cost, will be needed in the future to give us a substantial competitive advantage?		

29. Does your firm have a specific strategy for internal integration of technological forecasting? Yes_____ No_____

V. MANAGEMENT GAMES OR SIMULATION

30. Does your firm use computers in any aspect of its operation? Yes_____ No_____

31. Has your firm any experience in adopting and implementing a "decision information system" computerized or other?

a) Computerized Yes_____ No_____

b) Other (please specify) Yes_____ No_____

_____

_____

32. Has your firm ever used a management game or simulation in Research and Development selection and/or Product Development?

Yes_____ No_____

a) If yes, please describe briefly the area(s) in which a game or simulation was utilized.

_____

_____

_____

b) Was the game or simulation computerized? Yes_____ No_____

c) Was it successful? Yes_____ No_____

33. Has your firm ever used a management game or simulation in any part of its planning activity other than Product Development and Research and Development?

Yes_____ No_____

a) If yes, please describe briefly the area(s) in which a game or simulation was utilized.

_____

_____

_____

b) Was the game or simulation computerized? Yes_____ No_____

c) Was it successful? Yes_____ No_____

34. As indicated in the covering letter we are interested in further in-depth analysis in order to build a management game or simulation model that can be used both experimentally and as an aid for helping project managers learn about techniques that are useful in the project selection decision.

a) Would your firm, if selected, be willing to participate in on-site interviews (conducted at our expense)?

Yes_____ No_____

b) If current research is successful, would your firm be willing to participate in such an experimental management game or simulation?

Yes_____ No_____

2. Provide specific information with respect to the product development stream in organizations engaged in R & D.
3. Provide information about the sophistication of Canadian managements with respect to the use of formal decisionmaking techniques for R & D project selection.
4. Provide information about the changes taking place in corporate structures in Canada.
5. Find out whether Canadian firms are trying to shape their futures through the use of technological forecasting.
6. Get a general "feel" for the use of management games or simulations by Canadian firms.

It is worth mentioning that some information and impressions which were not objects of direct investigation through use of the questionnaire, were obtained through personal letters returned both with and without questionnaires as well as during personal interviews.

D. The Sample

Questionnaires were mailed to approximately 550 different Canadian firms who reported R & D activity as of the fall of 1973. Replies were received from 236 firms. Of these responses 196, over 35%, resulted in usable questionnaires while the remaining 40 fell into the personal letter, too late to be included in the data base, or nonusable categories.

Table II-1 summarizes the geographic location of the respondents. Approximately 84% of those firms responding are located in Ontario and Quebec. There were no questionnaires received from firms located in the Maritimes.

Table II-2 shows the position in the firm of persons completing the questionnaire. As indicated, 143 out of 196 or about 73% of the respondents were top management personnel. This means that the sample represents top management perception with respect to decisionmaking. In part, this result was probably due to our policy of mailing the questionnaire to the company president whenever his name and corporate address were known.

Table II-3 shows the Canadian geographic area, i.e., Canadian market area, of business activity for responding firms. Over 88 percent of those responding do business in all parts of Canada. As indicated on Table II-4, 90 percent of the respondents also do business internationally.

Table II-5 shows that 46 percent of the sample were firms engaged solely in manufacturing, while another 35 percent were in more than one industrial classification with the remaining firms being fairly evenly dispersed over the other major industrial classifications.

TABLE II-1

GEOGRAPHIC LOCATION OF RESPONDING FIRMS

Location	Absolute Frequency Firms	Relative Frequency %
British Columbia	15	7.7
Alberta	8	4.1
Saskatchewan	2	1.0
Manitoba	6	3.1
Ontario	118	60.2
Quebec	46	23.5
Missing Data	1	0.5
	196	100.0

TABLE II-2

POSITION IN FIRM OF PERSONS COMPLETING THE QUESTIONNAIRE

Position	Absolute Frequency Firms	Relative Frequency %
President	37	18.9
General Manager	18	9.2
Director of R & D	45	23.0
Vice President	27	13.8
Director of Engineering	7	3.6
Secretary / Treasurer	9	4.6
Laboratory Manager	5	2.6
Divisional Manager	25	12.8
Missing Data	23	11.5
	196	100.0

TABLE II-3

GEOGRAPHIC AREA OF BUSINESS ACTIVITY FOR RESPONDING FIRMS

Geographic Area	Absolute Frequency Firms	Relative Frequency %
All Parts of Canada	173	88.5
British Columbia	1	0.5
Alberta	4	2.0
Manitoba	1	0.5
Ontario	2	1.0
Quebec	3	1.5
British Columbia & Ontario	1	0.5
British Columbia, Alberta, Saskatchewan, Manitoba & Ontario	3	1.5
All But P.E.I.	1	0.5
British Columbia, Alberta, Manitoba, Ontario, Quebec	1	0.5
British Columbia, Alberta, Manitoba, Ontario	1	0.5
Ontario & Quebec	1	0.5
Quebec & Newfoundland	1	0.5
Missing Data	3	1.5
	196	100.0

TABLE II-4

NUMBER OF RESPONDING FIRMS WHO SELL TO INTERNATIONAL MARKETS

Sell To International Markets	Absolute Frequency Firms	Relative Frequency %
Yes	177	90.3
No	16	8.2
Missing Data	3	1.5
	196	100.0

TABLE II-5

INDUSTRIAL CLASSIFICATION OF RESPONDING FIRMS

Industrial Classification	Absolute Frequency Firms	Relative Frequency %
Agriculture	7	3.6
Forestry	3	1.5
Mining	7	3.6
Manufacturing	91	46.4
Construction	2	1.0
Transportation	4	2.0
Communication	6	3.1
Utility	3	1.5
Service	3	1.5
Defense	1	0.5
More Than One Classification	69	35.3
	196	100.0

E. Summary

The data base resulting from the responses of the 196 technologically based organizations is heavily weighted with respect to top management of manufacturing firms doing business internationally whose headquarters are located in Ontario and Quebec. This should be kept in mind when interpreting results.

Some of the more interesting comments from personal letters received from a variety of firms both large and small and which in some cases speak much louder than the so called "hard data" obtained from the questionnaires are included below.

1. "We regret the necessity of doing so but very few of the questions are pertinent to our operations and in addition we are being deluged with requests of this nature at the present time."

2. "Legislation passed by the Federal Government in 1969 virtually eliminated industrial property rights from the prescription pharmaceutical manufacturing industry.

   A revision in the Patents Act permitted the exercise of compulsory license against any patent holder producing prescription pharmaceutical products at a rate of 4% of net sales. Therefore the climate for either pure or applied research and development in Canada in the prescription pharmaceutical industry is imperiled, as it provides neither protection nor incentive to the R & D based originator."

3. "We have not completed your questionnaire, as most of the questions could not be applied to our plant. We are basically a manufacturing unit producing vinyl resins from vinyl chloride monomer. A considerable amount of process and product development work is carried out, but very little research. Projects are selected by plant technical and production engineers."

4. "As consulting engineers specialising in new product and process development, we help many of our clients with their innovative programs, including R & D. Much of our work involves marketing-oriented assessment of new products and processes. However, the attitude and degree of sophistication with which our clients approach such matters varies widely from one client company to another. In these circumstances, we feel that there is no meaningful way in which we could complete your questionnaire. If there is any other cooperation we could give you, please advise. Our experience suggests that the questions in your survey need to be raised and dealt with in Canada, and we wish you every success."

5. "We have examined the questionnaire carefully and find that most of the questions are extremely difficult to answer with a simple check mark or by indicating yes or no. We have concluded that there is no way in which we can respond to your questionnaire which would give you any useful information at all on the development and application of technology in our company."

6. "In your recent questionnaire on Research and Development you outlined a number of techniques in question 27. We are not familiar with many of these terms and therefore would like a definition of them."

7. "We are a producer and distributor of pharmaceuticals, chemicals, printing plates, fibres and dyestuffs. It is for this reason difficult to provide answers to your questions which would be applicable to our entire organization. We have, therefore, after careful consideration decided not to participate in your project."

8. "Upon reviewing the scope of the questionnaire, it became obvious to me that it was designed for much larger companies, with more complex research and development facilities than we have here.

   We have a procedure for consideration of new product lines, but it is reasonably informal and certainly not very sophisticated in comparison with the assimilated models and other concepts outlined in your survey."

9. "I regret to inform you that we will not be responding to the questionnaire. The difficulty is that we would regard the time and effort spent in replying to your questions as wasted since it is most unlikely that the data deriveable from the survey will add appreciably to what has resulted from many previous studies on this subject.

In formulating the questions you have based them on the conventional wisdom which currently relates to this subject. It is my opinion that the basic assumptions underlying current thinking are largely fallacious. I refer specifically to the following:

a. innovation generally originates in the R & D laboratory

b. the lack of innovation in Canada is due to the lack of industrial R & D

c. innovation proceeds according to an "innovation process" of the form shown on p. 2 of the questionnaire

d. technology forecasting is a useful activity.

There are several more which could be added.

The assumption which is really basic is the concept that innovation originates in the R & D laboratory. While there are examples which could be quoted in support of the assumption (and some outstanding ones at that) such studies as have been done indicate that the industrial R & D laboratories do <u>not</u> form the major source of innovation. For example, a number of studies quoted in the so-called "Charpie Report" of the U.S. Department of Commerce, "Technological Innovation: Its Environment and Management" show that the major sources of innovation are the <u>lone entrepreneurs and small companies</u>. If R & D was really the key to innovation, then obviously most of it should come from the large industrial research laboratories, but it doesn't.

The concept that there is an abstract process (the "innovation process") which describes the way innovation occurs is a myth. It is related to the obsolete idea that research is done according to a "scientific method". The truth is that research, like innovation, is an intensely <u>human</u> activity.

The key to innovation is the entrepreneur. It takes an individual, or small group of individuals, with great enthusiasm and dedication to make innovation happen in spite of barriers placed in their way. It requires commitment of a large amount of time, effort and resources to accomplish the goal. It is human devotion to achieving a set target which is the essence of innovation, rather than R & D. Of course, R & D is involved, but its main function is to support and refine the innovation.

Innovation does occur also in a large company, but even there a dedicated and enthusiastic individual is usually behind it. In a large R & D laboratory, some degree of formal structure is required, and in such a context some of the questions in your questionnaire would make sense. Since Canadian-owned companies possessing large research and development laboratories are rather scarce, I feel that the data you will acquire will have little relevance to the solution of Canada's industrial problems.

Finally, I should point out that even if all the government programs in support of innovation were successful, it would not solve our basic industrial problem, which is a lack of Canadian-owned companies. We need a Canadian ownership policy, not a foreign ownership policy. We need Canadian owned companies and if some prove to be innovative that would be a bonus."

10. "In the area of research and development from the manufacturing side, we depend virtually entirely on U.S. headquarters, who have a controlling interest in our company.

    Our marketing people, on the other hand, conduct extensive R & D work but in this regard it pertains primarily to existing product lines or new innovations and products coming out of U.S. headquarters, in order to measure their viability to the Canadian scene."

11. "Your study is of high interest to me, as the type of information sought is the one which we are trying to obtain on a continuing basis in the conduct of our business. Being an industrial research center which contracts development projects with private concerns who may benefit from our academic engineering resources, our company is always on the look-out for new industrial development needs."

12. "We are in receipt of your questionnaire regarding the climate for technological innovation in Canada. Because of the large number of surveys that we are asked to complete and the time involved to answer each one properly, we regret very much that we will be unable to comply with your request."

13. "I wish to apologise for the delay in returning the survey questionnaire which you sent me on January 15th, but I have been literally snowed under with similar documents which have constantly arrived on my desk during the past six weeks. It seems that everybody in Canada is engaged in the most soul-searching exercise I have ever seen, even in the hay-days of the Lamontagne Committee confrontations!"

14. "A relatively small company engaging in the range of activities briefly summarized above must necessarily employ many, if not most of the techniques itemized in your questionnaire but generally in an informal manner and on a scale befitting the scope of each individual decision."

15. "We would be interested in learning something of the management simulation techniques as they may relate to new product development."

16. "Our company has captured the Canadian market for our type of product and are now shipping over 75% of our production around the world. It is with considerable bitterness that I must report we have been trying for almost two years for grant assistance from our government to the extreme detriment of our operations.

    You would be doing the country a great service in my mind if you point out that well over half the employment in this country is provided by small businesses which is by its nature Canadian owned. Perhaps the government should learn to interface with this element of the industrial scene rather than try to make it conform to IBM standards."

SECTION III

PRODUCT DEVELOPMENT

A. Rationale For Questionnaire

Traditionally, products were the focus of marketing and marketing personnel devoted the majority of their time and effort to the search for customers once the products had been developed.

In the last three decades (post World War II years) North America has enjoyed a dynamic economy, one in which the design, development, and marketing of new products is of tremendous importance. Toffler indicates that "as the general rate of change in society accelerates, the economics of permanence are replaced by the economics of transience."[12] That is, accelerating change has made increasing demands for new product innovation. Weston has stated, "manifestations of increased technological changes are: the higher rates at which older products have been obsoleted; the shorter life of individual product life cycles; the increased risks of product substitution; and, the expansion of attractive growth potentials in new and diverse sectors of the economy."[13]

---

12. Toffler, Alvin, Future Shock, Random House, Inc., New York, 1970, p. 57.

13. Weston, J. Fred, New Technologies, Competition and Antitrust, National Industrial Conference Board, New York, 1970, p. 9.

At the same time that there is increased pressure for new products many firms have had to face the dilemma of new product failure. Studies conducted by several management consulting firms indicate very high rates of failure. Booz, Allen and Hamilton, Inc., stated, "of every 58 ideas, 12 pass initial screening, 7 survive a profit evaluation stage, 3 survive the product development stage, and only 1 is commercially successful."[14] Thus, it is the unusual company which does not continually have several new product proposals in various stages of evolution.

Concurrently with this era of increased pressure, a new marketing concept has developed which has as its focus customers rather than products.

The implication of this change in focus is that marketing personnel are required to provide advice throughout the product innovation stream. Therefore, one would expect a totally integrated marketing function within the firm to emerge. Kotler says:

> "Marketing's short-run task may be to adjust customers' wants to existing goods, but in the long-run it is to adjust the goods to the customers' wants. This point, that production must start with customer needs, is embodied in the new marketing concept. It enlarges the role of marketers from one of selling what has been produced to one of influencing what is being produced. Marketing may

---

14. Booz, Allen and Hamilton, Inc., Management of New Products, 4th Edition, New York, 1965, p. 9.

> stand officially at the end of the assembly line, but unofficially its influence must be felt on the drawing boards."[15]

This implies that the stages of the product planning process have both marketing and technical aspects. Obviously marketing departments and research and development units work independently on some aspects of product development, but there are many occasions when the interaction of the two groups is necessary to attain the next level in the product innovation stream. As a matter of fact, there is a degree of uncertainty about when marketing and research and development personnel should collaborate which is not resolved by the literature or survey results.[16]

Based on the present stage in the evolution of the new marketing concept, the increased demand for new product innovation, and the lack of empirical data as pointed out by Clarke, we decided that a portion of the current research program involving an investigation of the climate for technological innovation in Canada should be devoted to the question:

> When should marketing and research and development collaborate in the product innovation stream?

---

15. Kotler, Philip, Marketing Management: Analysis, Planning and Control, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1966, p. 3.

16. Clarke, "Decision Making," op. cit., p. 11.

To address this question, a schematic was adopted, as shown on page 2 of the questionnaire, which is representative of one possible corporate alignment of work flow in the new product innovation stream.[17] The schematic consists of eight stages, each of which is described briefly below.

Stage I Management Determination - Concerned with the establishment of the company mission, identifying growth opportunities, evaluating company resources and analyzing major corporate problems.

Stage II Exploration - Idea generation and idea collection in terms of company objectives.

Stage III Screening - A quick analysis to determine whether marketing and production is feasible and warrants further investigation.

Stage IV Business Analysis - The expansion of an idea into a concrete business recommendation including product features, performance characteristics and the nature and extent of demand.

Stage V Development - Turning the idea-on-paper into a product-in-hand including product prototype models, product testing and analysis of production costs.

---

17. Adler, Lee, "Systems Approach To Marketing," Harvard Business Review, May-June, 1967.

Stage VI Testing - The commercial experiments necessary to verify early business judgments including the testing of marketing programs.

Stage VII Commercialization - Launching the product into full scale production and sale wherein manufacturing must gear up for full scale production and marketing must be prepared to handle full scale product introduction.

Stage VIII Evaluation - Post introduction analysis to determine whether the product should remain on the market or be deleted from the product line.

Once the schematic was adopted, an attempt was made to answer the fundamental question about the collaboration of marketing and research and development. The questionnaire was designed to gather data about what the firms actually do with respect to such collaboration and also what respondents thought would be an ideal scheme for collaboration.

The following six themes for questions were articulated on the questionnaire.

Actual

1. When is marketing brought into the product innovation stream?
2. What level of marketing management is brought into the product innovation stream?

3. What degree of influence do marketing personnel have in the collaboration process?

Ideal

4. When should marketing be brought into the product innovation stream?
5. What level of marketing management should be brought into the product innovation stream?
6. What degree of influence should marketing personnel have in the collaboration process?

Themes 1 and 2 are the basis of question 8 on the questionnaire, theme 3 is the basis of question 9, themes 4 and 5 are the basis of question 10, and theme 6 is the basis of question 11.

In addition, the questionnaire asked whether the firms use or should use consultants in the product innovation stream. Some additional marketing items are found in other parts of the questionnaire and are appropriately discussed in the relevant rationale sections.

In essence, we wanted to see if Canadian firms are customer oriented and to determine where in the product innovation stream collaboration between marketing and R & D personnel exists or is thought to be desirable.

The portion of the questionnaire devoted to product development is shown in the next section and reflects the discussion presented above.

B. Actual Questionnaire

That portion of the survey questionnaire devoted to product development is shown on the next page.

C. Profile Data

This section is limited to the discussion of the responses to the product development section of the questionnaire which are summarized in Tables III-1, III-2, III-3 and III-4. Each table includes the amount of marketing collaboration presently existing in responding firms and also what survey respondents think the ideal collaboration scheme should be.

A close examination of Table III-1 indicates the actual and ideal collaboration schemes are virtually identical. This may, to a degree, reflect the fact that the respondents to the questionnaire were primarily top management. Therefore, top management is simply saying that they think they are doing the right thing. If we ignore this point for a moment and review the responses by stages in the product innovation stream, a large number of respondents (65-70 percent) involve marketing at very early stages. This is totally consistent with the new marketing concept. Only in the cases of development and testing is there a reduced involvement of marketing personnel. These represent areas where interaction is expected to be less. One does not expect to find marketing highly involved in the development laboratory. In the case of testing, one expects marketing to be involved in test marketing programs but not in product testing

II. PRODUCT DEVELOPMENT

Terminology used in the following section of the questionnaire

(1) Management Determination of product fields and markets of primary interest.

(2) Exploration - the search for new product ideas which meet company objectives.

(3) Screening - quick analysis to determine which ideas warrant investigation.

(4) Business Analysis - the expansion of an idea, through creative analysis, into a concrete business recommendation including product features and a program.

(5) Development - turning the idea-on-paper into a product-in-hand.

(6) Testing - the commercial experiments necessary to verify early business judgments

(7) Commercialization - launching the product in full-scale production and sale.

(8) Evaluation - post introduction evaluation to determine whether to continue or drop the new product.

Schematic - the following schematic represents one possible corporate alignment of work flow for management of new products.

Management Determination 1	→	Explor-ation 2	→	Screening 3	→	Business Analysis 4	→	Develop-ment 5	→	Testing 6	→	Commercial-ization 7	→	Evaluation 8

8. Would you please indicate (√) at what point(s) in the above schematic marketing personnel are brought into the product innovation stream and what level of management is brought in.

Schematic Number	Marketing Personnel Brought in	Marketing Personnel Not Brought in	Level of Management Brought in: Top	Middle	Line	Other (e.g. Consultants) (please specify)
1	____	____	____	____	____	_____
2	____	____	____	____	____	_____
3	____	____	____	____	____	_____
4	____	____	____	____	____	_____
5	____	____	____	____	____	_____
6	____	____	____	____	____	_____
7	____	____	____	____	____	_____
8	____	____	____	____	____	_____

9. Would you please indicate (√) the degree of influence marketing personnel have when they are brought into the product innovation stream.

No Influence ____ ____ ____ ____ ____ ____ ____ Total Influence

10. Would you please indicate (√) at what point(s) in the above schematic marketing personnel should be brought into the product innovation stream and what level of management should be brought in.

Schematic Number	Marketing Personnel Should be Brought in	Marketing Personnel Not Brought in	Level of Management Should be Brought in: Top	Middle	Line	Other (e.g. Consultants) (please specify)
1	____	____	____	____	____	_____
2	____	____	____	____	____	_____
3	____	____	____	____	____	_____
4	____	____	____	____	____	_____
5	____	____	____	____	____	_____
6	____	____	____	____	____	_____
7	____	____	____	____	____	_____
8	____	____	____	____	____	_____

11. Would you please indicate (√) the degree of influence marketing personnel should have when they are brought into the product innovation stream.

No Influence ____ ____ ____ ____ ____ ____ ____ Total Influence

TABLE III-1

THE NUMBER OF FIRMS INDICATING INVOLVEMENT OF MARKETING PERSONNEL IN EACH STAGE OF THE PRODUCT INNOVATION STREAM (QUESTIONS 8 AND 10)

	Stages In The Product Innovation Stream		Marketing Personnel Are			Marketing Personnel Should		
			Brought In	Not Brought In	Missing Data	Brought In	Not Be Brought In	Missing Data
1.	Management Determination	Firms	145	19	32	145	12	39
		%	(74.0)	(9.7)	(16.3)	(74.0)	(6.1)	(19.9)
2.	Exploration	Firms	125	23	48	120	15	61
		%	(63.8)	(11.7)	(24.5)	(61.2)	(7.6)	(31.1)
3.	Screening	Firms	123	25	48	119	16	61
		%	(62.8)	(12.7)	(24.5)	(60.7)	(8.2)	(31.1)
4.	Business Analysis	Firms	128	17	51	129	12	55
		%	(65.3)	(8.7)	(26.0)	(65.8)	(6.1)	(28.1)
5.	Development	Firms	77	55	64	82	39	75
		%	(39.3)	(28.1)	(32.7)	(41.8)	(19.9)	(38.3)
6.	Testing	Firms	104	34	58	103	27	66
		%	(53.1)	(17.3)	(29.6)	(52.6)	(13.8)	(33.7)
7.	Commercialization	Firms	141	5	50	135	3	58
		%	(71.9)	(2.5)	(25.5)	(68.9)	(1.5)	(29.6)
8.	Evaluation	Firms	138	5	53	135	6	55
		%	(70.4)	(2.5)	(27.0)	(68.9)	(3.1)	(28.1)

in the engineering sense.

The level of marketing management actually or ideally involved in the collaboration scheme is shown in Table III-2. Again, the actual and ideal schemes are virtually the same. The important consideration at this point is the organizational level of personnel involved. Most of the respondents are included when one groups top and middle management together. Only in the stages involving development and testing is there any substantial response indicating involvement of line management.

Table III-4 dealing with the use of consultants indicates that the majority of firms do not utilize outside consultants. Some consultants may be hired for specific problems or tasks but generally Canadian firms indicate they are self sufficient.

An interesting result is shown in Table III-4. The respondents indicated that marketing personnel already have a high degree of influence in the actual collaboration scheme and, ideally, should have more. We interpret this to mean that top management is willing, and perhaps ready, to further increase the amount of influence that marketing personnel have with respect to the product innovation stream.

D. Interaction Data

Table III-5 relates marketing variables with the location of the firm. There appears to be an East-West split in the data. Management determination, exploration, and commercialization were significantly attached to location of firm in both the actual and

TABLE III-2

THE NUMBER OF FIRMS INDICATING THE LEVEL OF MARKETING MANAGEMENT WHO ARE OR SHOULD BE INVOLVED IN EACH STAGE OF THE PRODUCT INNOVATION STREAM (QUESTIONS 8 AND 10)

Stages In The Product Innovation Stream		Level Of Management						
		Top	Mid	Line	Top + Mid	Top + Line	Mid + Line	Top + Mid + Line
		Number Of Firms						
1. Management Determination	Are	113	10	1	31	0	1	7
	Should Be	106	10	2	30	0	1	7
2. Exploration	Are	44	51	3	25	0	8	6
	Should Be	35	51	3	23	0	10	7
3. Screening	Are	41	52	5	24	0	9	5
	Should Be	38	50	4	26	0	10	4
4. Business Analysis	Are	54	39	4	29	0	8	12
	Should Be	46	38	4	31	0	9	12
5. Development	Are	23	37	13	14	1	27	11
	Should Be	16	42	17	12	1	21	12
6. Testing	Are	23	40	28	12	0	25	11
	Should Be	18	42	26	12	0	26	9
7. Commercialization	Are	43	19	11	21	0	14	35
	Should Be	40	22	9	19	0	20	29
8. Evaluation	Are	57	21	3	31	0	5	26
	Should Be	50	19	3	33	0	3	28

TABLE III-3

THE NUMBER OF FIRMS INDICATING WHETHER CONSULTANTS ARE OR SHOULD BE INVOLVED IN EACH STAGE OF THE PRODUCT INNOVATION STREAM (QUESTIONS 8 AND 10)

Stages In The Product Innovation Stream	Consultants Are Brought In (Firms)	Consultants Should Be Brought In (Firms)
1. Management Determination	9	6
2. Exploration	8	9
3. Screening	4	4
4. Business Analysis	9	3
5. Development	11	5
6. Testing	12	5
7. Commercialization	6	4
8. Evaluation	5	4

TABLE III-4

THE NUMBER OF FIRMS INDICATING THE AMOUNT OF INFLUENCE MARKETING PERSONNEL HAVE OR SHOULD HAVE IN THE PRODUCT INNOVATION STREAM (QUESTIONS 9 AND 11)

	Level Of Influence	Marketing Has Influence		Marketing Should Have Influence	
		Firms	%	Firms	%
1.	No Influence	3	1.5	3	1.5
2.		5	2.6	2	1.0
3		12	6.1	7	3.6
4.	Equal Influence With Others	32	16.3	27	13.8
5.		59	30.1	59	30.1
6.		46	23.5	60	30.6
7.	Total Influence	23	11.7	21	10.7
8.	Missing Data	16	8.2	17	8.7
	Mean Score	5.000		5.256	

TABLE III-5

LOCATION OF FIRM CROSSTABULATED WITH MARKETING VARIABLES
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

Marketing Variables			Location Of Firm
1. Marketing Are Brought In			
Stage	I	Management Determination	Significant at 0.0029
Stage	II	Exploration	Significant at 0.0004
Stage	V	Development	Significant at 0.0253
Stage	VII	Commercialization	Significant at 0.0005
Stage	VIII	Evaluation	Significant at 0.0007
2. Marketing Should Be Brought In			
Stage	I	Management Determination	Significant at 0.0286
Stage	II	Exploration	Significant at 0.0582
Stage	VII	Commercialization	Significant at 0.0062

the ideal innovation scheme. Essentially eastern firms are more market conscious in this group than the western firms, the latter being resource based and not selling to end users.

When the marketing variables were analyzed relevant to the industrial classification of the firms, similar patterns emerged. In addition to the east/west phenomenon, the manufacturing group appeared more variable than other groups and was generally underrepresented in the significant crosstabulations shown in Table III-6. In addition, because of the large number of manufacturing firms, the responses for that industrial class tended to vary more than for industrial classes with a small number of responses. That is, if an industrial class had only three or four responses it is possible that all respondents answered a question the same way, thus, contributing to a significant crosstabulation because of no variety in response.

Table III-7 crosstabulates research and development in corporate structure with the marketing variables. The actual and ideal responses for collaboration in the product innovation stream and the level of management utilized in the process do not vary appreciably. The pattern is the same as the profile for total sample which was discussed in the preceding section. This is not unexpected, as most firms responding to the questionnaire had research and development sections as part of larger corporate structures.

Table III-8 indicates that the organization of research and development activities are significant with only a few

TABLE III-6

INDUSTRIAL CLASSIFICATION CROSSTABULATED WITH MARKETING VARIABLES
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

Marketing Variables	Industrial Classification
1. Marketing Are Brought In	
Stage I Management Determination	Significant at 0.0068
Stage VIII Evaluation	Significant at 0.0515
2. Level Of Management Brought In	
Stage I Management Determination	Significant at 0.0016
Stage IV Business Analysis	Significant at 0.0014
Stage V Development	Significant at 0.0216
Stage VII Commercialization	Significant at 0.0210
3. Marketing Should Be Brought In	
Stage I Management Determination	Significant at 0.0007
Stage V Development	Significant at 0.0317
4. Level Of Management Should Be Brought In	
Stage I Management Determination	Significant at 0.0002
Stage V Development	Significant at 0.0291
5. Marketing Influence Should Be	Significant at 0.0848

TABLE III-7

FIRMS WITH R & D IN CORPORATE STRUCTURE CROSSTABULATED WITH MARKETING VARIABLES

Marketing Variables			Response Categories					
			Brought In		Not Brought In		Missing Data	
			Are	Should Be	Are	Should Be	Are	Should Be
1. Marketing								
Stage	I	Management Determination	137	136	17	11	42	49
Stage	II	Exploration	117	111	20	13	59	72
Stage	III	Screening	115	111	22	13	59	72
Stage	IV	Business Analysis	120	120	15	10	61	66
Stage	V	Development	73	77	51	35	72	84
Stage	VI	Testing	98	97	31	24	67	75
Stage	VII	Commercialization	133	126	3	2	60	68
Stage	VIII	Evaluation	128	125	4	5	64	66
			Top/Mid		Line		Missing	
			Are	Should Be	Are	Should Be	Are	Should Be
2. Level Of Management Brought In								
Stage	I	Management Determination	144	136	8	9	44	51
Stage	II	Exploration	117	107	9	10	70	79
Stage	III	Screening	116	113	10	8	70	75
Stage	IV	Business Analysis	119	112	16	16	61	68
Stage	V	Development	96	86	20	24	80	86
Stage	VI	Testing	94	92	35	30	67	74
Stage	VII	Commercialization	92	93	42	35	62	68
Stage	VIII	Evaluation	106	96	27	29	63	71
3. Level Of Influence Of Marketing Personnel			Mean Scale Value		Actual (Are)		5.12	
					Ideal (Should Be)		5.28	

TABLE III-8

ORGANIZATION OF R & D ACTIVITIES CROSSTABULATED WITH MARKETING VARIABLES
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

Marketing Variable	Organization Of R & D Activities
1. Level Of Management That Are Brought In At Screening Stage	Significant at 0.0339
2. Level Of Management That Should Be Brought In At Development Stage	Significant at 0.0241
3. Marketing Influence Should Be	Significant at 0.0184

marketing variables. The majority of the significance resulted from the effect of missing data. In the case of the development stage, the significant result was expected because marketing is not as involved at this stage in the innovation stream and would be even less involved in pure research and development organizations.

When the marketing variables are related to research and development project selection models, the significant results may be due to the fact that project selection models are only used at various levels of the firm at different points of time. The use of project selection models was only significant when the marketing variables were evaluative in nature. This is not unexpected as the project selection models are also evaluative as well as selective in nature.

Several factors considered by firms in research and development project selection are marketing variables. The influence of marketing personnel was found to be significantly related to four factors: market potential, market trends, relationship with existing markets and marketing strategy (see Table III-10). In essence, as marketing influence increases, the four factors become more important. This introduces additional marketing factors into the collaboration scheme and is totally consistent with the profile data, i.e., marketing is considered to be important and many marketing factors should be considered in the various stages of the product innovation stream.

TABLE III-9

R & D PROJECT SELECTION MODELS CROSSTABULATED WITH MARKETING VARIABLES
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

Marketing Variables	Models
Level Of Management That Are Brought In At Business Analysis Stage	1. Ranking Models Significant at 0.0574
Level Of Management That Should Be Brought Into The Evaluation Stage	2. Constrained Optimization Models Significant at 0.0165
Level Of Management That Should Be Brought Into the Evaluation Stage	3. Risk Analysis Models Significant at 0.0343

TABLE III-10

MARKETING PERSONNEL INFLUENCE CROSSTABULATED WITH FACTORS CONSIDERED IN R & D PROJECT SELECTION
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

Factors	Marketing Personnel Influence
1. Market Potential	Significant at 0.0001
2. Market Trends	Significant at 0.0148
3. Relationship With Existing Markets	Significant at 0.0432
4. Product Market Strategy	Significant at 0.0001

Two other significant crosstabulations are reported in Table III-11. Changes in marketing control was found significantly related to the actual level of marketing management brought into the testing stage. The significance was due to the length of time that had elapsed since marketing controls had changed. If the change occurred more than five years ago, it had been institutionalized and delegated. If it was a recent change, control remained with top management. The testing stage was a stage with less high level marketing personnel involved and the changes in marketing controls had been recent in most firms. Hence, the significance at the testing stage.

Product - Market strategy was found significantly related to the ideal level of marketing influence. This result indicates that strategy and ideal influence are directly related, i.e., where more strategy is required, more marketing influence is needed.

Several additional support data appear in other tables in the report. Those that relate to marketing are summarized here for continuity.

Table IV-9 indicates that market analysis and a new product committee are very important components of new product generation.

In Table IV-10 part c, the low importance attached to corporate image was surprising. The firms indicate a high degree of market orientation and yet fail to link marketing, product line and corporate image in a meaningful way. The lack

TABLE III-11

OTHER SIGNIFICANT CROSSTABULATIONS

	Level Of Marketing Management That Are Brought Into The Testing Stage
Changes In Marketing Control	Significant at 0.0215
	Marketing Influence Should Be
Product Market Strategy	Significant at 0.0005

of consideration of market risk during development again portrays an innovative-risk-taking-non-traditional picture of Canadian managers.

In Section V on structure, four tables provide insight into marketing. Table V-1 indicates a large number of the firms have changed marketing objectives and controls within the past five years. Table V-5 indicates that solely research and development firms also are tending to be more marketing oriented while Table V-6 indicates a similar pattern for firms with research and development as part of corporate structure.

Table V-7 indicates that changes in marketing controls are significantly related to flexibility of structure, i.e., the more flexible firms changed marketing controls more recently.

Table VI-10 indicates that market share and relationship with existing markets are significantly related to the technical advantages of a firm's products, i.e., if technical advantages are viewed as important, market variables are also viewed to be important.

E. Summary

The analysis of the profile of marketing involvement in new product innovation presented in Section C leads to several conclusions. First, Canadian companies are customer oriented consistent with the new marketing concept and involve marketing personnel to a high degree in most stages of the product innovation stream. The firms look for customer needs or desires

through market research and bring the results back to the initial production conceptualization phase.

Second, marketing personnel presently involved in the product innovation stream are/should be from top and middle management. In essence, Canadian firms involve marketing to a great extent, and when they do, the level of personnel is very senior.

Third, the degree of influence extended by marketing personnel is large and there is an indication that top management thinks that it should be increased.

Thus, high level, influential marketing personnel are involved in the product innovation stream. This tends to dispel any notion that Canadian management is unconcerned about customer wants and needs. The interesting point is that Canadian managers are not lagging behind their counterparts in other countries in the use of current marketing management skills and orientation.

The interaction data in Section D led to several additional conclusions, most of which support those already stated above. First, there is an east-west phenomenon related to market proximity which tends to generate significant interaction results when location of firm and industrial classification are considered. The eastern industrial base in more heterogeneous whereas many industrial sectors are underrepresented in the west. Hence, one general Federal research and development policy for all of Canada may be somewhat inappropriate. Second, research

and development appears to have its strongest technical link to marketing when selection and evaluative processes are involved. Third, typical marketing factors - market potential, market trends, relationship with existing markets and marketing strategy - were found to be significantly related to the influence of marketing personnel, a result consistent with the profile data. Fourth, recent changes in marketing objectives and marketing control support the conclusion that Canadian firms are very much customer oriented and have undergone recent changes to bring marketing objectives and control more in line with current marketing ideology.

New product decisions play a dominant role in the formation of corporate strategy. The data indicates the importance of new product innovation to Canadian firms. It also indicates, very strongly, that Canadian firms are customer as well as market oriented. In addition, there are innovative marketing firms which attach importance to the involvement of high level, influential marketing personnel in the product innovation stream from conceptualization to commercialization. This is not the picture so often pained about conservative, traditional, non-innovative and unimaginative Canadian managers. In fact, from a marketing point of view, analysis of survey data generates an entirely different model of Canadian management.

SECTION IV

RESEARCH AND DEVELOPMENT PROJECT SELECTION

A. Rationale For Questionnaire

The purpose of the portion of the questionnaire devoted to R & D project selection was to gather basic data about R & D project selection in technologically based Canadian firms. There is, to our knowledge, very little Canadian oriented information of this kind available. Basic information obtained from the questionnaire is necessary in order to better delineate the basic requirements of an experimental and management development program for Canadian R & D project selection decision-makers.

B. Actual Questionnaire

Those portions of the survey questionnaire designed to probe the state-of-the-art in Canada with respect to R & D project selection are shown on the next three pages. A brief discussion of the background to the questionnaire is presented below.

Questions 6 and 7 were included in order to empirically establish the organization and orientation, i.e., pure vs. applied, of R & D activity throughout Canada.

III. RESEARCH AND DEVELOPMENT PROJECT SELECTION

6) Would you please indicate (✓) whether your firm is solely engaged in Research and Development or whether Research and Development activities are part of a larger corporate structure.

a) Solely Research and Development _____

b) Research and Development is part of corporate structure _____

7) Please indicate (✓) the way in which your Research and Development activities are organized.

a) Pure Research and Development _____

b) Applied Research and Development _____

c) Mix of Pure and Applied Research and Development _____

d) Other (would you please briefly describe below?) _____

_____

_____

_____

_____

12. Does your firm use Research and Development project selection techniques? Yes___ No___

13. Would you please indicate (✓) below whether your firm is currently using, has used in the past, plans to use in the future, or has never used the following Research and Development project selection techniques.

Terminology

a) Ranking Models where the decision maker compares one project with another or a grouping of projects and selects which he prefers.

b) Scoring Models which compute an overall project score based on rating of the project against preselected critical criteria.

c) Economic Models which employ calculations such as net present value, internal rate of return, or economic equations.

d) Constrained Optimization Models which attempt to optimize an economic objective function subject to specific resource constraints.

e) Risk Analysis Models which are based on a simulation analysis of input data in distribution form.

TECHNIQUES	used for past 2 years	used for past 2-5 years	used for longer than 5 years	plan to use in future	have never used	used but discarded (Give year discarded)
a) Ranking Models						
b) Scoring Models						
c) Economic Models						
d) Constrained Optimization Models						
e) Risk Analysis Models						

14. If your firm is not using any of the above Research and Development project selection techniques would you make a brief statement as to why this is so.

_____

_____

_____

_____

15. Is your firm satisfied with its present procedures for selection of Research and Development projects?

Yes_____ No_____

16. Do present procedures used for the selection of Research and Development projects involve the use of probability estimates for technical and/or commercial success?

a) For technical success Yes____ No____

b) For commercial success Yes____ No____

17. Are specific Research and Development projects selected from multiple proposals or are they looked at one at a time?

a) From multiple proposals Yes____ No____

b) Looked at one at a time Yes____ No____

18. Please describe briefly steps taken by your firm to stimulate the generation of Research and Development and/or New Product ideas.

_____

_____

_____

_____

_____

19. What factors are used by your firm to evaluate Research and Development projects? Please check (✓).

a) Research and Development
- Likelihood of technical success ___
- Development cost ___
- Development time ___
- Capability of available skills ___
- Availability of R&D resources ___
- Availability of R&D facilities ___
- Patent status ___
- Compatibility with other projects ___

b) Manufacturing
- Capability of manufacturing product ___
- Facility and equipment requirements ___
- Availability of raw material ___
- Manufacturing safety ___

c) Corporate Objectives
- Fits into overall objectives and strategy ___
- Corporate image ___

d) Financial
- Profitability ___
- Capital investment required ___
- Annual (or unit) cost ___
- Rate of return on investment ___
- Unit price ___
- Payout period ___
- Utilization of assets, cost trend, cost reduction, and cash flow ___

e) Timing
- Timing of introduction of new product ___
- Expected product sales life ___

f) Marketing and Distribution
- Size of potential market ___
- Capability to market product ___
- Market trend and growth ___
- Customer acceptance ___
- Relationship with existing markets ___
- Market share ___
- Market risk during development period ___
- Pricing: trend, propriety problem, geographical extent, and effect on existing products ___
- Complete product line and quality improvement ___

22. To what degree does your firm agree with the following statements? Please check (√).

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
a) Formal decision processes help in logically consistent decisions	____	____	____	____	____
b) Formal decision processes allow research management to more clearly identify those projects or ideas which are well worth investing time and money in and those which are not	____	____	____	____	____
c) Formal decision processes allow termination of unsuccessful projects at the earliest possible time	____	____	____	____	____
d) Formal decision processes make managers aware of information that should be acquired when making decisions on projects or ideas	____	____	____	____	____
e) The primary objective of using formal decision processes is to make decisions for managers	____	____	____	____	____
f) The primary objective of using formal decision processes is to aid managers in making decisions	____	____	____	____	____

23. Who in your organization makes decisions regarding the following types of Research and Development programs?

	Person and/or group in organization
a) Exploratory Research and Development Programs	_____
b) High risk business development Research and Development programs	_____
c) Support of existing business Research and Development programs	_____

24. Do considerations of scientific break-throughs internal or external to your firm influence funding patterns for Research and Development activities?

Yes____ No____

25. Do you have some intuitive or operational criteria for the identification of a "good funding pattern?"

Yes_____ No_____

Question 13 essentially uses the classification of models or techniques proposed by Moore and Baker and discussed by Clarke.[18] We were also interested here in trying, if possible, to establish trends in usage over time.

Question 14 was designed to try to verify the reason for the lack of use of models, if such proved to exist. Clarke provides a composite of reasons for nonuse which may not apply to Canadian firms.[19]

Question 16 was included in order to try to ascertain the degree to which managers presently try to quantify their subjective judgments. This area of decisionmaking is important, particularly in the design of a management development program designed to provide guidance to managers wishing to make more accurate forecast estimates. Clarke elaborates on this point.[20]

Baker and Freeland make the point that perhaps there is a growing recognition that it is easier and more meaningful for R & D personnel to evaluate alternative project portfolios than to evaluate isolated proposals. They claim that this is likely to be the case in situations involving multiple criteria and a dominance of economic return as a factor in resource allocation

---

18. Clarke, "Project Selection," op. cit., p. 3.

19. Ibid., pp. 10 and 11.

20. Ibid., pp. 9 and 10.

decisions.[21] Question 17 was included in order to get a rough feel for this aspect of the decisionmaking process existing in Canadian firms.

Question 18 was designed to get at some of the current steps taken by management to help promote innovation.

Question 19 is the list of factors generated by Dean and discussed by Clarke as being the important ones used by firms for selection and evaluation of R & D projects.[22]

Question 22 was included to obtain management's current thinking about the reasons for using quantitative decisionmaking techniques, while Question 23 attempted to identify the decision-maker.

Baker and Freeland discuss the input requirements for project selection and resource allocation models.[23] As pointed out, only point estimates of value are required where funding levels are not considered. If resource allocation models are used, some type of function must be specified which relates benefit to feasible funding levels associated with projects under

---

21. Baker, Norman R., and Freeland, James R., "Recent Advances In R & D Value Measurement and Project Selection Methods," A paper presented at the 41st National Meeting of ORSA, New Orleans, Louisiana, April 26-28, 1972, p. 16.

22. Clarke, "Decision Making," op. cit., pp. 17-20 and Appendix D.

23. Baker and Freeland, op. cit., p. 13 and 14.

consideration. Questions 24 and 25 represent a back door effort to try to gain additional insight into the level of sophistication of R & D management's thinking, even though they may not be using formal quantitative approaches. This consideration of perspective on funding patterns is important to the design of future research into factors affecting R & D management's willingness to adopt quantitative techniques, and to the general orientation of a management development program as well.[24]

C. Profile Data

Tables IV-1 shows that the majority of R & D activity, 90%, takes place in R & D units that are part of a larger corporate entity. In addition, R & D activity is heavily application oriented, as shown on Table IV-2.

About 32% of the reporting firms, as shown on Table IV-3, use no quantitative project selection techniques. However, and this is important and somewhat surprising, almost 59% of responding firms do use such techniques. The trend in specific usage that shows up, in Table IV-4, is from the use of simpler ranking and scoring models towards the use of more sophisticated economic, constrained optimization, and risk analysis models. However, 25% of the reporting firms have been using economic models, probably capital budgeting kinds of models since this model type was implicit in the definition used for economic models on the questionnaire, for longer than five years.

---

24. See Section VIII of this report.

TABLE IV-1

THE NUMBER OF FIRMS INDICATING WHETHER THEY ARE SOLELY ENGAGED IN R & D OR WHETHER R & D ACTIVITIES ARE PART OF A LARGER CORPORATE STRUCTURE (QUESTION 6)

	Absolute Frequency Firms	Relative Frequency %
Engaged Solely In R & D	17	8.7
R & D Activities Are Part Of The Corporate Structure	178	90.8
Both	1	0.5
	196	100.0

TABLE IV-2

ORGANIZATION OF R & D ACTIVITIES (QUESTION 7)

Organization Of R & D	Absolute Frequency Firms	Relative Frequency %
Pure R & D	3	1.5
Applied R & D	137	70.0
Mixture Of Pure And Applied R & D	53	27.0
Missing Data	3	1.5
	196	100.0

TABLE IV-3

THE NUMBER OF FIRMS USING R & D PROJECT SELECTION TECHNIQUES (QUESTION 12)

Use R & D Project Selection Techniques	Absolute Frequency Firms	Relative Frequency %
Yes	115	58.7
No	62	31.6
Missing Data	19	9.7
	196	100.0

TABLE IV-4

THE NUMBER OF FIRMS USING SPECIFIC R & D PROJECT SELECTION TECHNIQUES (QUESTION 13)

		Techniques				
		Ranking Models	Scoring Models	Economic Models	Constrained Optimization Models	Risk Analysis Models
Used For Past 2 Years	Firms	16	6	15	5	11
	%	(8.2)	(3.1)	(7.7)	(2.6)	(5.6)
Used For Past 2-5 Years	Firms	28	14	25	11	10
	%	(14.3)	(7.1)	(12.8)	(5.6)	(5.1)
Greater Than 5 Years	Firms	53	11	49	15	10
	%	(27.0)	(5.6)	(25.0)	(7.7)	(5.1)
Plan To Use In Future	Firms	6	12	8	7	11
	%	(3.1)	(6.1)	(4.1)	(3.6)	(5.6)
Have Not Used	Firms	39	73	42	79	73
	%	(19.9)	(37.2)	(21.4)	(40.3)	(37.2)
Used But Rejected	Firms	2	4	1	1	3
	%	(1.0)	(2.0)	(0.5)	(0.5)	(1.5)
Missing Data	Firms	52	76	56	78	78
	%	(26.5)	(38.8)	(28.6)	(39.8)	(39.8)
Total		196	196	196	196	196

Table IV-5 is very interesting. While many of the nonusers were not able or were unwilling to articulate the reason for nonuse, for example, one respondent actually stated that he did not know why the techniques itemized on the questionnaire were not used, the predominate answer from nonusers was that their firm was too small or more importantly they lacked knowledge of the techniques.

Table IV-6 indicates that about 58% of the firms are satisfied with their present R & D project selection techniques, while 38% are not satisfied with present techniques. This represents about the same breakdown as users vs. nonusers.

Fifty-eight percent of the responding firms use probability estimates to identify probable technical success while 62% of reporting firms use probability estimates in regard to probable commercial success. We think that this represents a fairly high level of sophistication and were, frankly, surprised at the results.

The data on Table IV-8 coincides with the results, discussed above, with respect to the fact that the majority of users favor simple ranking or scoring models. Only 43% of the firms select projects from multiple portfolios. This would involve data, such as that obtained from constrained resource allocation models, which would require decisionmakers to ascertain funding patterns rather than point estimates of value for projects under consideration. Constrained resource allocation models do not enjoy a large usage. However, even though

TABLE IV-5

REASONS WHY FIRMS DO NOT USE R & D PROJECT SELECTION TECHNIQUES
(QUESTION 14)

Why Techniques Are Not Used	Absolute Frequency Firms	Relative Frequency %
Only Make Simple Decisions	6	3.1
Techniques Are Not Necessary, Do Not Work	7	3.6
Firm Is Too Small	10	5.1
Lack Knowledge Of Techniques	16	8.1
Firm Is Product Oriented	1	0.5
Lack Of Capability And Resources	2	1.0
Clients Direct Firm	5	2.6
Projects Selected By Priority	2	1.0
Narrow Markets	1	0.5
Do Not Know	1	0.5
Satisfied With Present Procedures	2	1.0
Contemplating Adding	2	1.0
Decisions Made Elsewhere	1	0.5
Missing Data	140	71.5
	196	100.0

TABLE IV-6

THE NUMBER OF FIRMS INDICATING SATISFACTION WITH THEIR PRESENT R & D PROJECT SELECTION TECHNIQUES (QUESTION 15)

Satisfied With Present Procedures	Absolute Frequency Firms	Relative Frequency %
Yes	113	57.7
No	73	37.2
Missing Data	10	5.1
	196	100.0

TABLE IV-7

THE NUMBER OF FIRMS WHO USE PROBABILITY ESTIMATION FOR TECHNICAL AND/OR COMMERCIAL SUCCESS (QUESTION 16)

Use Probability		Technical Success	Commercial Success	Both Commercial And Technical Success
Yes	Firms	115	122	104
	%	(58.7)	(62.2)	(53.1)
No	Firms	65	59	80
	%	(33.2)	(30.1)	(40.8)
Missing Data	Firms	16	15	12
	%	(8.2)	(7.7)	(6.1)

TABLE IV-8

THE NUMBER OF FIRMS WHO SELECT R & D PROJECTS FROM SINGLE OR MULTIPLE PROPOSALS (QUESTION 17)

		Projects Selected		
		From Multiple Proposals	From Single Proposals	Both
Yes	Firms	84	136	34
	%	(42.9)	(69.4)	(17.3)
No	Firms	46	16	152
	%	(23.5)	(8.2)	(77.6)
Missing Data	Firms	66	44	10
	%	(33.7)	(22.4)	(5.1)

such models are not being used, Table IV-3 indicates that over one-half of those who were able or willing to respond to question 25 have intuitive or operational criteria for identification of a "good" funding pattern. In addition, about 61% of the total respondents, say that scientific breakthroughs influence funding patterns for R & D activities. Again, this indicates a generally high degree of management sophistication.

Table IV-9 shows the potpourri of methods used to stimulate innovation in R & D thinking. It is interesting to note that 24% of the firms report market analysis as being the prime-mover. Necessity and survival are the mother and father of innovation!

Table IV-10 indicates that only 37% of the firms consider manufacturing safety when evaluating R & D proposals. This provides some insight into recent union activity and upheaval, in both the U.S. and Canada, with respect to safety considerations on the job. What is really surprising is that 69% of the responding firms do not consider corporate image when evaluating R & D proposals. This seems to be contrary to the popular picture painted about the importance of image in corporate decisionmaking.

Table IV-11 indicates that the majority of management thinks that formal decision processes aid decisionmaking generally and that the primary objective of the use of quantitative techniques is to aid decisionmaking rather than to make decisions.

TABLE IV-9

HOW FIRMS STIMULATE THE GENERATION OF R & D AND/OR NEW PRODUCT IDEAS (QUESTION 18)

Steps In R & D And New Product Idea Generation	Absolute Frequency Firms	Relative Frequency %
Decision Model	8	4.1
Limit To Experts	3	1.5
Originate In R & D	15	7.7
Market Analysis	46	23.5
Systematic Approach	45	23.0
Ad Hoc	15	7.7
To Meet Customer Need	6	3.1
Brainstorming	7	3.6
From Parent Company	1	0.5
New Product Committee	18	9.2
Creative President	2	1.0
Pick By Priority	1	0.5
Missing Data	29	14.6
	196	100.0

TABLE IV-10

FACTORS USED BY RESPONDING FIRMS TO EVALUATE R & D PROJECTS
(QUESTION 19)

Factors	Factors Considered: Yes — Firms	Factors Considered: No — Firms
a) Research And Development		
Likelihood of Technical Success	175	21
Development Cost	162	34
Development Time	151	45
Capability of Available Skills	149	47
Availability of R & D Resources	138	58
Availability of R & D Facilities	130	66
Patent Status	118	78
Compatibility With Other Projects	137	59
b) Manufacturing		
Capability of Manufacturing Product	162	34
Facility and Equipment Requirements	145	51
Availability of Raw Material	114	82
Manufacturing Safety	73	123
c) Corporate Objectives		
Fits Into Overall Objectives and Strategy	176	20
Corporate Image	61	135
d) Financial		
Profitability	169	27
Capital Investment Required	154	42
Annual (or Unit) Cost	96	100
Rate of Return on Investment	142	54
Unit Price	94	102
Payout Period	115	81
Utilization of Assets, Cost Trends, Cash Flow	105	91

TABLE IV-10 Continued

Factors	Factors Considered: Yes (Firms)	Factors Considered: No (Firms)
e) Timing		
Timing of Introduction of New Product	122	74
Expected Product Sales Life	118	78
f) Marketing and Distribution		
Size of Potential Market	163	33
Capability to Market Product	141	55
Market Trend and Growth	141	55
Customer Acceptance	149	47
Relationship With Existing Markets	143	53
Market Share	111	85
Market Risk During Development Period	89	107
Pricing: Trend, Propriety Problem, Geographical Extent, and Effect on Existing Products	117	79
Complete Product Line and Quality Improvement	127	69

TABLE IV-11

THE EVALUATION OF FORMAL DECISION PROCESSES BY RESPONDING FIRMS (QUESTION 22)

Statements		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Missing Data
a) Formal decision processes help in logically consistent decisions	Firms	36	115	19	10	0	16
	%	(18.4)	(58.7)	(9.7)	(5.1)	(0.0)	(8.2)
b) Formal decision processes allow research management to more clearly identify those projects or ideas which are well worth investing time and money in and those which are not	Firms	40	115	14	8	1	18
	%	(20.4)	(58.7)	(7.1)	(4.1)	(0.5)	(9.2)
c) Formal decision processes allow termination of unsuccessful projects at the earliest possible time	Firms	31	115	15	16	1	18
	%	(15.8)	(58.7)	(7.7)	(8.2)	(0.5)	(9.2)
d) Formal decision processes make managers aware of information that should be acquired when making decisions on projects or ideas	Firms	44	115	13	4	0	20
	%	(22.4)	(58.7)	(6.6)	(2.0)	(0.0)	(10.2)
e) The primary objective of using formal decision processes is to make decisions for managers	Firms	1	12	19	104	40	20
	%	(0.5)	(6.1)	(9.7)	(53.1)	(20.4)	(10.2)
f) The primary objective of using formal decision processes is to aid managers in making decisions	Firms	43	112	13	9	1	18
	%	(21.9)	(57.1)	(6.6)	(4.6)	(0.5)	(9.2)

TABLE IV-12

ORGANIZATIONAL DECISION MAKERS FOR VARIOUS TYPES OF R & D PROGRAMS (QUESTION 23)

Who In Organization	Programs					
	Exploratory R&D Programs		High Risk Business Development R&D Programs		Support Of Existing Business R&D Programs	
	Firms	%	Firms	%	Firms	%
President	21	10.7	34	17.3	23	11.7
Board	3	1.5	10	5.1	7	3.6
Top Management	62	31.6	72	36.7	60	30.6
Top Management Committee	10	5.1	12	6.1	11	5.6
General Manager	4	2.0	11	5.6	8	4.1
Research Director	39	19.9	7	3.6	26	13.3
Vice President(Various)	18	9.2	14	7.1	13	6.6
Marketing Manager	11	5.6	3	1.5	18	9.2
Mid Management	5	2.6	7	3.6	14	7.1
Missing Data	23	11.7	26	13.3	16	8.2
Totals	196	100.0	196	100.0	196	100.0

TABLE IV-13

PATTERNS OF FUNDING (QUESTIONS 24 AND 25)

Statements	Yes Firms	%	No Firms	%	Missing Firms	%
Question 24						
Do considerations of scientific breakthroughs internal or external to your firm influence funding patterns for R & D activities?	119	(60.7)	63	(32.1)	14	(7.1)
Question 25						
Do you have some intuitive or operational criteria for the identifications of a "good funding pattern?"	87	(44.4)	82	(41.8)	27	(13.8)

Table IV-12 indicates that, in general, top management participates across the board in decisionmaking for various types of R & D programs. However, clearly, Research Directors play a larger role, as might be expected, in exploratory R & D programs.

D. Interaction Data

Tables IV-14, IV-15, IV-16, IV-17, and IV-18 report crosstabulations, of R & D project selection variables with other variables included in the questionnaire, that showed up in the computer analysis as being statistically significant.

Table IV-14 indicates that, as expected since more head offices are located in eastern Canada, more decisionmaking with respect to R & D activity takes place in the east.

Data underlying Table IV-15 indicates that manufacturing firms are less sophisticated than other technologically based Canadian corporations in the use of quantitative techniques for R & D project selection.

Tables IV-16 and IV-17 indicate that market sensitive firms, i.e., firms where R & D activity is part of a larger corporate structure, use more advanced decisionmaking techniques for R & D project selection than firms organized on a pure R & D basis. The small number of purely R & D oriented firms accounts for the significant crosstabulations shown on Table IV-18. Pure R & D is generally done on a contract basis and management of

TABLE IV-14

LOCATION OF FIRM CROSSTABULATED WITH VARIOUS FACTORS
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

Factors	Location Of Firm
a) Who In The Organization Decides About Exploratory R & D Programs	Significant at 0.0115

TABLE IV-15

INDUSTRIAL CLASS CROSSTABULATED WITH VARIOUS FACTORS
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

	Factors	Industrial Class
a)	Constrained Optimization Models	Significant at 0.0002
b)	Risk Analysis Models	Significant at 0.0037
c)	Decider of High Risk R & D Projects	Significant at 0.0001
d)	Decider of Projects That Support Existing R & D Projects	Significant at 0.0015

TABLE IV-16

FIRMS ORGANIZED AS SOLELY R & D CROSSTABULATED WITH R & D VARIABLES

R & D Variables	Response Categories: Yes	No	Missing Data
a) Use R & D Project Selection Techniques	11	4	181

Models	Past 2 Years	Past 2-5 Years	Greater Than 5 Years	Have Not Used	Missing Data
b) Ranking Models	3	1	1	5	186
c) Scoring Models	0	0	0	10	186
d) Economic Models	1	3	2	7	183
e) Constrained Optimization Models	1	1	1	8	185
f) Risk Analysis Models	1	0	0	9	186

	Yes	No	Missing Data
g) Present R&D Procedures Are Ok	9	8	179
h) Use Probability Estimates Of Technical Success	8	10	178
i) Use Probability Estimates Of Commercial Success	6	9	181
j) Projects Selected From Alternative	9	3	184
k) Projects Selected Individually	12	2	182
l) Concerned About Corporate Image	15	3	178
m) Concerned About Asset Utilization	11	7	178
n) Concerned About Manufacturing Safety	13	5	178

TABLE IV-16 Continued

		Yes	No	Missing Data
o)	Concerned About Market Share	12	6	178
p)	Concerned About Market Risk	14	4	178
q)	Breakthrough Influences Funding	10	8	178
r)	Criteria For Funding Pattern	8	8	180

		Level Of Decision		
		Top Management	Mid Management	Missing Data
s)	Decisions Regarding Exploratory R & D	14	1	181
t)	Decisions Regarding High Risk R & D	13	0	183
u)	Decisions Regarding Programs In Support Of Existing R & D	14	1	181

TABLE IV-17

FIRMS WITH R & D IN CORPORATE STRUCTURE CROSSTABULATED WITH R & D VARIABLES

R & D Factors	Yes	No	Missing Data
a) Use R & D Project Selection Techniques	105	58	33

Models	Past 2 Years	Past 2-5 Years	Greater Than 5 Years	Have Not Used	Missing Data
b) Ranking Models	13	27	52	42	62
c) Scoring Models	6	14	11	79	86
d) Economic Models	15	22	47	44	68
e) Constrained Optimization Models	4	10	14	79	89
f) Risk Analysis Models	10	10	10	78	88

	Yes	No	Missing Data
g) Present R&D Procedures Are OK	104	66	26
h) Use Probability Estimates Of Technical Success	107	56	33
i) Use Probability Estimates Of Commercial Success	116	50	30
j) Projects Selected From Alternatives	75	43	78
k) Projects Seclected Individually	125	14	57
1) Concerned About Corporate Image	121	58	17
m) Concerned About Asset Utilization	81	98	17
n) Concerned About Manufacturing Safety	111	68	17

TABLE IV-17 Continued

	Yes	No	Missing Data
o) Concerned About Market Share	74	105	17
p) Concerned About Market Risk	94	85	17
q) Breakthrough Influences Funding	110	55	31
r) Criteria For Funding Pattern	80	74	42

	Level Of Decision		
	Top Management	Mid Management	Missing Data
s) Decisions Regarding Exploratory R & D	144	15	37
t) Decisions Regarding High Risk R & D	148	10	38
u) Decisions Regarding Programs In Support Of Existing R & D	135	31	30

TABLE IV-18

OTHER STATISTICALLY SIGNIFICANT CROSSTABULATIONS

	Emphasis Of R & D Activities (Pure, Applied, Mixed)
a) Decider Of High Risk R & D	Significant at 0.0006
b) Criteria For Funding Pattern	Significant at 0.0139

firms operating in this sector have very little need to evaluate funding patterns for R & D or the relative technological or commercial risks, with respect to success, of such projects.

E. Summary

We think that the results of this portion of the study show that Canadian management, in general, is much more sophisticated than usually they are given credit for being. The degree of the recent lament by Daly and Peterson is probably unwarranted, at least in the area of R & D decisionmaking.[25] Where data on the use of quantitative techniques is strictly comparable, Canadian managers are probably relatively no worse off or better off than their U.S. counterparts.[26] There does seem to be a need to increase the knowledge level and perspective among the smaller Canadian firms. Also, a well designed management development program, applied to larger firms, would perhaps accelerate the use of more sophisticated quantitative techniques, at least in the R & D area. The degree of management sophistication, shown in responses to the "funding pattern questions," i.e., questions 24 and 25, indicates a readiness if not a willingness on management's part to adopt more sophisticated decisionmaking aids. Indeed, as indicated in the data portrayed on Table IV-4, the trend is in that direction. With respect to "education" of the smaller firms with respect to modern decisionmaking techniques, one thing that came through

---

25. Daly and Peterson, op. cit.

26. See Section VII of this report.

in interviews, implicitly but loud and clear, was the fact that the business leaders on the Canadian scene spend a great deal of time and effort in this direction. As a matter of fact they may be over extended in this effort, and the truth of the matter is that such efforts are not widely recognized nor rewarded.

It is highly significant to find that manufacturing firms lag behind other industries in the application of quantitative techniques in R & D project selection decisionmaking. This general decisionmaking lethargy of the manufacturing sector of Canadian industry also shows up in the use of technological forecasting techniques.[27] We recognize that the amount or degree of lag in sophistication of decisionmaking among manufacturing firms has not been established, but to be reasonably certain of such existence is highly disconcerting when one considers the long-run ability of Canadian manufacturing firms to compete in world markets. The implicit assumption here, of course, is that manufacturing firms lag in the use of more sophisticated decisionmaking techniques in all areas, not just in the area of R & D project selection. Recent trends in wages across the board in Canada would seem to indicate that Canadian manufacturing firms cannot, in the future, depend on a cheaper supply of labor to offset operational inefficiences that might arise as a result of deficiency in management decisionmaking practices.

---

27. See Section VII of this report.

However, as indicated in Section III of this report, Canadian firms, including manufacturers, are comparable in the use of advanced techniques in the area of marketing. What they lack in the area of sophistication in R & D decisionmaking, is perhaps more than offset by marketing effort and savvy. In addition, the diverse nature of the size of Canadian manufacturers may distort the data. We are certain that the larger Canadian firms are as sophisticated as their counterparts south of the border. At this point in time, data from the questionnaire is not organized in such a manner that the influence of firm size can be readily discerned.

SECTION V

STRUCTURAL CHANGE IN CANADIAN ORGANIZATIONS DOING RESEARCH AND DEVELOPMENT

A. Rationale For Questionnaire

Any thorough fundamental investigation into the design requirements for an experimental and management development program for R & D project selection decisionmakers needs to consider the structure of R & D organizations. Structure is usually considered in the narrow sense of hierarchy. However, hierarchy is only one important aspect of structure. In 1958, March and Simon pointed out that organization structure consists simply of those aspects of the pattern of behavior in the organization that are relatively stable and that change only slowly.[28] Their discussion of structure and thinking about structure was oriented towards how the "boundaries of rationality" affected management of an organization's programs for performing tasks, switching rules for determining when it will apply alternative programs, and the procedures used for developing, implementing, and revising programs. Now, if structure is viewed in reverse, i.e., by asking what are the fundamental organizational components which affect managerial behavior that

---

28. March, James G., and Simon, Herbert A., Organizations, John Wiley & Sons Inc., Fourth Printing, March 1963, p. 170.

change most slowly over time, an interesting and highly useful integrating framework for analysis evolves. This integrating framework suggests that organizational structure can also be defined as those organizational components that change most slowly over time and includes five fundamental aspects. These are; goals, control systems, people attitudes, hierarchy, and the data base. These five fundamental structural components of organizations are very important when one considers the use or nonuse of quantitative techniques by R & D project selection decisionmakers or the willingness of decisionmakers to adopt such techniques.

An organization's goals or objectives can be expected to change slowly over time because they affect the allocation of resources in development of programs for performing tasks and switching rules for program application. An accepted economic concept is the knowledge that resource commitment in the short run is fixed. The problem of assessing change requires a definition of what is meant by short run. Technological forecasting techniques discussed in Section VI of this report, particularly the delphi method, have been designed to assist in a more accurate definition of the time horizon. In addition, it might be expected that objectives change slowly over time because they are perhaps the most difficult component of organization structure for management to delineate. This difficulty and the relationship to the use, or willingness to use, quantitative techniques is very aptly pointed out by Letwin.

> "An executive's first job is to define the objectives of his organization: it is a rare book on operations research, management science, policy-making, or public administration that does not make this point at the outset. It is a good point, worth making and, like other good points, well worth qualifying. . . . . Yet although men and organizations cannot act rationally without having selected their ends, instructing a man to identify his ends, or those of his organization, sets him at a task that, while logically possible, is practically impossible."[29]

> "It seems, after all, that the textbooks must be admitted to be theoretically correct in holding that the first step in rational decision is to identify the objectives. What they do not add is that the project of identifying objectives is strictly interminable and imposes severe strains on the honesty as well as the intellect of the seeker. Above all, the project cannot be carried out by any scientific or objective method. Two men equally knowledgeable about an organization may well disagree about its objectives, and no third man could, on account of any science at his disposal, tell which of the two was more accurate. In short, the opening step in the presumably objective process of decisionmaking with modern methods is itself a step that requires analysis of a largely intuitive sort. At the very threshold of rational certainty in practical matters stands the uninvited guest of discretionary judgment."[30]

Control systems in the financial, production, and marketing areas can be expected to change slowly over time because of the initial cost of installation and the fact that human beings become

---

29. Letwin, William, "Social Science and Practical Problems," The Great Ideas Today, Encyclopaedia Britannica, Inc., Toronto, 1970, pp. 131-132.

30. Ibid., p. 133.

accustomed to using programs for task performance which are developed as an intrinsic part of adoption of systems for control of an organization's major functions.

By people attitudes we mean the fundamental beliefs held by management with respect to participation of employees in decisionmaking at all levels of the organization. The millions of dollars spent by industrial organizations in North America each year in sending personnel to management development programs in an effort to make operational the managerial perspective that employees are other than machines, attests to the fact that people attitudes are slow to change. The affect of an organization's basic attitude towards people on the cognitive rationality of employees is well established, but to our knowledge this fundamental organizational aspect has not been pointed out as being a major structural variable in the sense used here.

The hierarchy component of structure refers to what is most commonly called "the structure of an organization." By hierarchy we mean how the firm is organized. The most fundamental notion of organization, relevant to this investigation, is the trend towards greater centralization or decentralization. The trend towards centralization or decentralization is an important consideration in the use of scientific decisionmaking techniques by technologically based organizations. In 1960, Simon pointed out that the new developments in decisionmaking will tend to induce more centralization in decisionmaking

activities at middle management levels.[31] In 1970, Churchman stated:

> "This brings OR into what I consider to be the major organizational problem of management and government in the coming decades: centralization vs. decentralization. The problem for OR is somewhat of a paradox. The assumption implicit in OR models is that decisionmaking should have a centralized locus, where information from all sources is digested by the model and an optimal allocation of resources is calculated. But OR practitioners realize the importance of maintaining at least the appearance of local decisionmaking."[32]

Whisler, points out how information technology affects organization structure in systematic ways. He states:

> "How much the structure will change depends also on how economic it is to use information technology. Managers attempt to exploit the technology to the point where costs and benefits are equal. As hardware, software, and data transmission equipment improve, this point shifts, and the technology is usually exploited further. Since it thus appears that the use of computers will grow, it is useful to gather as much evidence as possible of the systematic changes the technology makes in organizational structure."[33]

---

31. Simon, Herbert A., The New Science of Management Decision, Harper and Row, New York, 1960, p. 47.

32. Churchman, C. West, "Operations Research As A Profession," Management Science, Vol. 17, October, 1970, p. B-44.

33. Whisler, Thomas L., Information Technology and Organizational Change, Wadsworth Publishing Company Inc., Belmont, California, 1970, p. 68.

Data bases developed by all levels of management can be expected to change slowly over time because they are used at all levels in the organization to drive programs used in task performance and as the basic input for switching rules, i.e., the input to corporate control systems, used to make decisions regarding alternative program application. A recent article in the Financial Post included a caption that stated, "For senior management, the important aspect of data-base technology is that it is not an end in itself. It is simply a technique for reorganizing data and changing the methods of assessing that data."[34] It is not unreasonable to expect such change to take place slowly over time as a result of the change in an organization's data base, because of the problems of novelty, inkblot character of technology, and self inflicted costs.[35]

The relationship between an organization's structure and the use of more scientifically based decisionmaking techniques by managers is now clear. What is not evident is how information with respect to structural changes in Canadian organizations doing R & D can be made operationally useful in the design of an experimental and management development program aimed at R & D project selection decisionmakers. As Whisler puts it:

> "One of the great blanks in organization theory is a systematic and satisfactory explanation of the grouping of activities,

---

34. Sharp, Duane E., "Phasing in the Computer," The Financial Post, April 13, 1974, p. 28.

35. These problems are described by Whisler, op. cit., p. 107.

> jobs, and people in organizations, even though this is one of the fundamental problems to be solved by those responsible for an organization's effective functioning. Recent lines of investigation, however, suggest that the costs of communication are a fundamental determinant of the pattern of departmentation within any organization. By trial and error, the organization seeks that structure which will minimize its costs, given the number and kinds of problems that it has to solve. These problems depend on the character and volume of its outputs."[36]

Perhaps the key lies in the investigations of Professor P. Michael Maher and others into the willingness of decision-makers to adopt quantitative techniques.[37]

B. Actual Questionnaire

The portion of the survey questionnaire used to ascertain the trends in structural change of Canadian organizations doing research and development is shown on the next page. As indicated, the questionnaire was designed to gather information both with respect to change and the perceived impact of such change on the morale and productivity of personnel directly engaged in R & D activity. We may be open to criticism for not being more explicit with respect to the definitions of "centralization" and "decentralization." We recognize that "centralization" indicates a direction rather than an absolute condition. We assumed that management answering the questionnaire

---

36. Ibid., p. 45-46.

37. See Section VIII of this report.

STRUCTURAL CHANGE IN CANADIAN ORGANIZATIONS DOING RESEARCH AND DEVELOPMENT

20. Would you please indicate (✓) whether there have been changes in corporate objectives, corporate control systems, corporate structure, professional development of Research and Development personnel, and type of information in the data base during the specified time periods.

	during past 2 years	during past 2-5 years	longer than 5 years	no change
a) Changes in objectives				
- Financial				
- Production				
- Marketing				
b) Changes in corporate control systems				
- Financial				
- Production				
- Marketing				
c) Changes in corporate structure				
- More centralized structure				
- More decentralized structure				
- Moved from line-staff to a program management structure				
d) Changes in professional development opportunities for Research and Development Personnel				
- Increased opportunity for professional development				
- Decreased opportunity for professional development				
e) Changes in sources or type of information included in the data base used for the selection of Research and Development projects				
- Changes in source				
- Changes in type				

21. Given your response to question 20 above, to what degree does your firm agree with the following statements regarding the impact of the changes on the morale of Research and Development personnel and on the output of the Research and Development unit. Please check (✓).

	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree
a) The changes in the following areas have led to increased morale of Research and Development personnel					
- Changes in objectives					
- Changes in corporate control systems					
- Moved toward a more centralized structure					
- Moved toward a more decentralized structure					
- Moved to a program structure					
- Increased professional development opportunity					
- Decreased professional development opportunity					
- Changed sources of information					
- Changed type of information					
b) The changes in the following areas have led to increased output from the Research and Development unit					
- Changes in objectives					
- Changes in corporate control systems					
- Moved toward a more centralized structure					
- Moved toward a more decentralized structure					
- Moved to a program structure					
- Increased professional development opportunity					
- Decreased professional development opportunity					
- Changed sources of information					
- Changed type of information					

would assess the direction of such change in their own organization. As pointed out by Whisler, centralization relates to distribution of controls of people and machines.[38] It was simply beyond the scope of this study to try to investigate in detail changes in the distribution of control within Canadian organizations engaged in R & D.

C. Profile Data

As shown on Table V-1 only 50% of the firms responding to the questionnaire report changes in financial and production objectives during the past five years. However, there is evidence of greater change in marketing objectives, particularly during the past two years. Even so, only 58% of the reporting firms report any change of marketing objectives during the past five years.

The same kind of stability is shown with respect to change in corporate control systems. Only 55%, 45%, and 48% of responding organizations, report changes in financial, production, or marketing control systems, respectively, during the past five years.

The same trend, i.e., lack of significant change, in corporate structure in terms of centralization, decentralization, or hierarchy to accommodate projects requiring program management is evident. In the sample of responding Canadian firms

---

38. Whisler, op. cit., p. 54.

TABLE V-1

ORGANIZATIONAL CHANGES BY RESPONDING FIRMS (QUESTION 20)

Changes In	Changes During Past 2 Years	Changes During Past 2-5 Years	Changes Longer Than 5 Years	No Change	Missing Data
	Firms				
a) Objectives					
Financial	64	34	15	57	26
Production	64	33	8	52	39
Marketing	75	38	10	42	31
b) Control Systems					
Financial	78	30	13	49	26
Production	57	32	14	51	42
Marketing	64	30	11	53	38
c) Corporate Structure					
More Centralized	42	17	11	69	57
More Decentralized	28	15	4	70	79
More Program	25	9	8	72	82
d) Professional Development					
Increased Opportunity	54	42	7	66	27
Decreased Opportunity	7	8	3	61	117
e) Information Or Data Based Used In R & D Project Selection					
Source Of Data	55	26	6	71	38
Type Of Data	47	23	7	67	52

engaged in R & D activity, 59 firms report a trend to a more centralized structure over the past five years, 69 firms report no significant trend towards either greater centralization or decentralization, while the remaining 43 firms report a trend towards greater decentralization during the same period. Since the answer to this question required interpretation on a relative basis by respondents, we have no way of making inter-firm comparisons with respect to degree of delegation of decisionmaking. Nevertheless, we interpret the results as meaning that the hierarchy of technologically based Canadian corporations is fairly static. What movement has taken place in hierarchy during the past five years seems to be in the direction of more centralization rather than decentralization but the split here is only slightly, 57% (59/102x100) vs 43%, in favor of centralization.

More firms report no change in professional development opportunities for R & D personnel, 66 firms, than report change, 54 firms, during the past two years. Over the past five years only 96 firms, or slightly less than one-half of those reporting, report change in opportunities for professional development by R & D personnel. It is interesting to note that 15 firms report that decreased opportunity for professional development by personnel engaged in R & D activity has obtained during the past five years. This might be construed as a negative change, the reasons for which are not readily apparent.

A similar analysis of the data presented on Table V-1 shows that there was the same kind of stability, i.e., lack of great change, in the data bases used by R & D project selection decisionmakers during the past five years. However, and this may reflect the increasing use of information technology, it is significant that organizations reporting changes in data bases have doubled during the past two years as compared with those reporting change in data bases which took place during the previous three years.

Table V-2 shows the data reporting whether those responding to the questionnaire thought that changes in organizational structure had improved morale and productivity of R & D personnel. There were only three structural changes which seemed to have affected morale. There is general agreement that changes in objectives and increased professional development increased the morale of R & D personnel. There is also a strong plurality that indicates that decreased emphasis in opportunity for professional development led to decreased morale of R & D personnel. The same thing can be said about the affect of structural changes on the productivity of R & D personnel. The significant result here is the degree of neutrality exhibited about the affect of other structural changes on the morale and productivity of R & D personnel. This coupled with the large amount of missing data indicates that executives generally had a difficult time in estimating the affect of structural changes on the morale and productivity of R & D personnel. Upon reflection

TABLE V-2

DEGREE TO WHICH ORGANIZATION CHANGES HAVE IMPROVED MORALE AND PRODUCTIVITY OF R & D PERSONNEL (QUESTION 21A AND B)

Changes In	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Missing Data
	Changes Have Improved Morale — Firms					
a) Objectives	22	71	40	8	1	54
b) Control Systems	6	53	57	18	2	60
c) Centralized Structure	5	34	50	18	5	84
d) Decentralized Structure	9	27	53	16	2	89
e) Program Structure	10	49	55	3	1	78
f) Increased Professional Development	28	67	32	1	0	68
g) Decreased Professional Development	0	5	44	25	12	110
h) Sources Of Information	8	45	58	6	1	78
i) Type Of Information	5	43	62	5	0	81
	Changes Have Improved Productivity					
a) Objectives	24	68	39	6	1	58
b) Control Systems	6	44	54	13	3	76
c) Centralized Structure	8	29	49	16	6	88
d) Decentralized Structure	7	24	52	14	2	97
e) Program Structure	10	45	53	4	1	83
f) Increased Professional Development	19	65	42	4	0	66
g) Decreased Professional Development	0	1	49	24	12	110
h) Sources Of Information	9	40	61	5	1	80
i) Type Of Information	8	38	65	3	0	82

this is what we should have expected. If an organization's fundamental structural components change slowly over time, one should expect that any assessment of such change could take place only over the long run. As indicated above, these components are changing slowly over time and any meaningful assessment in the short run is difficult for management to make.

D. Interaction Data

The crosstabulations of structural variables, which proved to be statistically significant with other seemingly important and related variables for which data was gathered, are shown on Tables V-3, V-4, V-5, V-6, V-7, V-8, and V-9. Significant changes in financial objectives occurred in eastern manufacturing firms. Manufacturing firms also tended to be the primary cause of significant crosstabulations with respect to moves towards greater centralization, changes from traditional line-staff oriented hierarchy to that involving program management, and changes in the data base. Recent changes in marketing and financial objectives were more prevalent in firms organized with R & D as part of a larger corporate structure than in firms which were solely R & D organizations. Results reported on Table V-7 indicate that firms which considered the flexibility of organization structure in the face of rapid technological change when considering R & D projects were also the firms where changes in financial objectives, production control systems, and marketing control systems had taken place. Interestingly enough,

TABLE V-3

LOCATION OF FIRM CROSSTABULATED WITH VARIOUS FACTORS
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

Factors	Location Of Firm
a) Change In Financial Objectives	Significant at 0.0326

TABLE V-4

INDUSTRIAL CLASS CROSSTABULATED WITH VARIOUS FACTORS
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

Factors	Industrial Class
a) Changes In Financial Objectives	Significant at 0.0185
b) Have Moved To More Centralized Structure	Significant at 0.0095
c) Have Moved From Line-Staff To Program Management	Significant at 0.0443
d) Have Changed Source Of Information	Significant at 0.0012

TABLE V-5

FIRMS ORGANIZED AS SOLELY R & D CROSSTABULATED WITH STRUCTURAL VARIABLES

Structural Variables	Firms Organized As Solely R & D: Changes In Past 2 Years	Changes In Past 2-5 Years	Changes Greater Than 5 Years	No Change	Missing Data
a) Changes In Financial Objectives	4	4	0	6	182
b) Changes In Production Objectives	4	2	0	3	187
c) Changes In Marketing Objectives	5	2	0	2	187
d) Changes In Financial Control	5	2	1	6	182
e) Changes In Production Control	1	1	2	5	187
f) Changes In Marketing Control	3	1	0	5	187
g) More Centralized Structure	3	2	0	8	183
h) More Decentralized Structure	0	0	0	6	190
i) From Line-Staff To Program Management	3	0	1	4	188
j) Increased Professional Development	4	5	0	5	182
k) Decreased Professional Development	1	0	0	5	190
1) Changed Source Of Information	6	3	0	6	181
m) Changed Type Of Information	4	2	0	5	185

TABLE V-6

FIRMS ORGANIZED WITH R & D AS PART OF CORPORATE STRUCTURE CROSSTABULATED WITH STRUCTURAL VARIABLES

Structural Variables	Firms With R & D As Part Of Corporate Structure: Changes In Past 2 Years	Changes In Past 2-5 Years	Changes Greater Than 5 Years	No Change	Missing Data
a) Changes In Financial Objectives	60	31	15	51	39
b) Changes In Production Objectives	60	31	8	49	48
c) Changes In Marketing Objectives	70	36	10	40	40
d) Changes In Financial Control	73	29	12	43	39
e) Changes In Production Control	56	31	12	46	51
f) Changes In Marketing Control	61	29	11	48	47
g) More Centralized Structure	39	16	11	61	69
h) More Decentralized Structure	28	15	4	64	85
i) From Line-Staff To Program Management	22	9	7	68	90
j) Increased Professional Development	50	38	7	61	40
k) Decreased Professional Development	6	8	3	56	123
l) Changed Source Of Information	49	24	6	65	52
m) Changed Type Of Information	43	21	7	62	63

TABLE V-7

FLEXIBILITY OF ORGANIZATION STRUCTURE CROSSTABULATED WITH STRUCTURAL VARIABLES
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

Structural Variables	Flexibility Of Structure
a) Changes In Financial Objectives	Significant at 0.0407
b) Changes In Production Control	Significant at 0.0019
c) Changes In Marketing Control	Significant at 0.0093
d) More Decentralized Structure	Significant at 0.0181

TABLE V-8

CROSSTABULATION OF R & D PROJECT SELECTION MODELS WITH STRUCTURAL VARIABLES
(ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

Structural Variables	Models
	1) Ranking Models
a) Changes In Production Control	Significant at 0.0244
b) Changes In Type Of Information	Significant at 0.0143
	2) Scoring Models
a) Changes In Type Of Information	Significant at 0.0077

TABLE V-9

OTHER STATISTICALLY SIGNIFICANT CROSSTABULATIONS

	Breakthrough Influences Funding Patterns
Changes In Financial Control	Significant at 0.0001

these same firms reported a tendency to move towards a more decentralized organization. We are not certain what this implies.

Table V-8 indicates that those firms using ranking models and scoring models for R & D project selection indicated changes in production control systems and/or changes in the type of information included in the data base. This would be expected and it is interesting to see that the data supports such contention.

When a firm reported a consideration of scientific breakthrough, internal or external to the organization, as influencing the funding pattern for R & D projects, they also reported recent changes in financial control systems, as shown on Table V-9.

E. Summary

It appears that the five fundamental structural variables of organizations - goals, control systems, people attitudes, hierarchy, and data base - are changing slowly over time in technologically based Canadian organizations. This may mean that one reason for nonadoption of quantitative techniques in decisionmaking is that the managers of organizations are able to adapt to change in other ways and are able to avoid the self-inflicted costs involved in learning and adopting new decision-making methods in the short run. Future research efforts should try to shed additional light in this area. We also interpret the change in marketing objectives as discussed above as indicating that any managment development program for R & D

decisionmakers should emphasize techniques for assessing long run market strategies, i.e., technological forecasting. In addition, we think the recent acceleration in change in the data bases of R & D organizations supports our thinking that the design of an experimental and management development program for R & D project decisionmakers should be computer oriented.

We think that the profile data supports our hypothesis that organization structure, as defined in this report, changes slowly over time. Hence, a paradox presents itself. Toffler reports that his research indicates organizations in the U.S. and Western Europe change their internal shape at a very rapid pace.[39] He quotes an official of McKinsey & Company as stating that organization problems are an even larger part of his company's consulting practice outside of the United States, and that frequency of organizational upheaval is increasing.[40] We will not make the flat statement that Toffler's picture of super-rapidity of organization change is wrong, we simply believe that it is superficial. The nature of the organizational change taking place needs to be investigated in detail. Certainly organizational change is an unavoidable response to the acceleration of change. But the real question is: Are the most fundamental components of organization structure, i.e., goals, control systems, people attitudes, hierarchy, and data base

---

39. Toffler, op. cit., pp. 128-132.

40. Ibid., p. 129.

changing at the "future shock" rate portrayed by Toffler? This study indicates that they are not, at least they are not in Canada. Accurate knowledge about the rate of change of structure, particularly the nature of the trend towards or away from centralization, is important because the allocation of resources to R & D projects is made at different levels and in different divisions of hierarchical organizations. Assessment of the impact of change in organizational structure is important in understanding the resource allocation process. An optimal allocation of available resources is the ideal towards which R & D project selection decisionmaker's strive.

SECTION VI

TECHNOLOGICAL FORECASTING

A. Rationale For Questionnaire

Technological forecasting is important in the management of technological change. It is not a new concept but has evolved from a variety of decisionmaking techniques developed during and since World War II. We think that the degree of recognition of the strengths and weaknesses of technological forecasting by scientists and managers is an important aspect of the "climate for technological innovation in Canada," and is important in the consideration of the design of an experimental and management development program for research and development project decisionmakers. Technological innovation takes place in technologically based organizations. Technologically based Canadian firms are primarily those reporting R & D activity. Therefore, the perspective of management and information available to management when making decisions affecting the potential results of innovative activity in the R & D area are very important to Canada. As one executive told us, "There is no way Canada can buy back those productive assets presently held by foreign firms. However, by being cognizant of the trends in technological developments which will affect goods and services produced in the future, Canadians can assure their ability to own the majority of the productive facilities developed in the future, if they so desire."

In a substantial report for the OECD published in July 1967, Erich Jantsch stated:

> "Technological forecasting which has developed gradually since the end of World War II, attempts to provide some indication of future trends. It is important for two main reasons. Firstly, the rapid growth of opportunity offered by the many advances in science and technology necessitates a high selectivity on the part of the decisionmaker both at the level of the individual firm and on a national scale. Choice between alternative paths may make all the difference in competitive performance. But there is a second and more important reason why technological forecasting is necessary. Science and technology are increasingly recognised as influences in the transformation of society and governments must therefore strive to foresee the impacts which technological developments are likely to have on future society and to guide the application of new knowledge in the attainment of national goals. Recognition of the possibility of planning for future options by guiding technological development along alternative paths in an economic, social and political context presents both a stimulus and a challenge to the policy-maker."[41]

In a book published in 1972 Wills states:

> "The evidence I have collected during the past five years points strongly to the value of technological forecasting as a tool for the detailed analysis of research and development budgeting procedures, and this of course has dramatic significance for corporate planners."[42]

---

41. Jantsch, Erich, Technological Forecasting In Perspective, Organization For Economic Co-operation and Development, Printed In France, July 1967, p. 11.

42. Wills, Gordon and et. al., Technological Forecasting, Penguin Books Ltd., Harmondsworth, Middlesex, England, 1972, p. 11.

> "Successful innovation, however, will normally require both marketing and technological innovation, and marketing and technological critique. The two are so closely interrelated that there cannot be work in one area without assumption and consequence that bear on the other."[43]

In an advanced treatment of technological forecasting published in 1972 Martino points out:

> "For the practicing scientist or engineer, the book provides information he will need to understand technological forecasting. There are three reasons why he will need such understanding. First, more and more scientists and engineers are going to be called upon to participate in the making of forecasts in the areas in which they are well informed. They should understand the methods that will be used by the professional forecasters with whom they will be required to collaborate. Second, technological forecasting will be increasingly used in the planning of scientific and technological activity. It is advantageous for them, therefore, to understand the bases upon which decisions will be made about their work. Third, technological forecasting can be of value in expanding the application of their work. Since most scientists and engineers are interested in seeing their work applied, technological forecasts can be of direct benefit to them. . . . . .Administrators in science and engineering, and other decisionmakers whose work will be influenced by technological change, will not usually be making detailed technological forecasts. Forecasts will be prepared for them by technical specialists and professional forecasters. Nevertheless, it is important for these decisionmakers to be aware of the methods commonly

---

43. Ibid., p. 16.

> used, to know when these methods are appropriate and when they are not, and particularly to know the strengths and weaknesses of the various methods."[44]

B. Actual Questionnaire

The portion of the survey questionnaire devoted to gathering data pertaining to "technological forecasting in Canada" is shown on the next page. As indicated, we were interested in finding out whether technologically based Canadian organizations were using technological forecasting techniques, what the trend over time seemed to be with respect to use, and the degree to which management recognized the importance of the relationship between marketing innovation and technological innovation as manifest through R & D activity and organization. We recognized that a semantic problem exists with respect to nomenclature related to specific technique(s) and simply used the same terminology as Wills.[45] One very knowledgeable executive told us that he bought several recent references, after receiving the questionnaire, and found that his firm was using similar technique(s) but used different nomenclature. We do not think that this problem appreciably affected the results obtained from the questionnaire data because of the large number of responses indicating no knowledge about technological

---

44. Martino, Joseph P., Technological Forecasting For Decision-making, American Elsevier Publishing Company, Inc., New York, 1972, pp. xv-xvi.

45. Wills, op. cit.

IV. TECHNOLOGICAL FORECASTING

26. Does your organization use technological forecasting techniques? Yes_____ No_____

27. Would you please indicate (√) below whether your firm is currently using, has used in the past, plans to use in the future, or has never used the following techniques in connection with Research and Development selection and/or Product Development.

TECHNIQUES	used for past 2 years	used for past 2-5 years	used for longer than 5 years	plan to use in future	have never used	used but discarded (Give year discarded)
a) Extrapolative Approaches						
b) Morphological Analysis						
c) Scenario Writing						
d) Impact Analysis						
e) Relevance Analysis						
f) Contextual Mapping						
g) Normex Reconciliation						
h) Delphi Method						
i) SOON Charting						
j) Technological Mission Analysis						

28. When considering Research and Development projects does your firm consider the following questions? Please check (√).

	Yes	No
a) Is Research and Development consistent with corporate strategy?		
b) Should we invest in the same technologies as our competition?		
c) How do we maximize the flexibility of our organization structure in the face of rapid technological change?		
d) How can technology transfer best be achieved from Research and Development to Manufacturing and Marketing?		
e) What kind of product/market strategy should we follow?		
f) What technical advantages in our products, at what cost, will be needed in the future to give us a substantial competitive advantage?		

29. Does your firm have a specific strategy for internal integration of technological forecasting?

Yes_____ No_____

forecasting whatsoever and the number of firms writing to us requesting a ready and readable reference. When answering such requests, Gordon Wills' book was recommended as an initial reference because it is written at an understandable level and is available in paperback.

C. Profile Data

Table VI-1 and Table VI-2 indicate that the majority, 53%, of those Canadian firms engaged in R & D who responded to the questionnaire are not using technological forecasting techniques. Of those 70 firms who indicate that they do use technological forecasting, as shown on Table VI-2, the majority, 30 firms, are referring to the use of traditional and routine extrapolative techniques such as regression analysis. Table VI-2 also shows that there has been some trend towards use of technological forecasting within the past five years and that use by users seems to have accelerated during the past two years. What seems to be significant is that very few firms are planning to use technological forecasting in the future.

Table VI-3 indicates that managements are highly cognizant of the relationship between marketing innovation and technological innovation as manifest through R & D. However, when considered in light of the conclusions reached above, technologically based Canadian management is not taking advantage of the additional information for decisionmaking that could be made available through results of technological forecasting. Perhaps talent or resources are not available or are not made available for

TABLE VI-1

NUMBER OF FIRMS USING TECHNOLOGICAL FORECASTING TECHNIQUES
(QUESTION 26)

Use Technological Forecasting Techniques	Absolute Frequency Firms	Relative Frequency %
Yes	70	35.7
No	104	53.1
Missing Data	22	11.2
	196	100.0

TABLE VI-2

THE NUMBER OF FIRMS USING SPECIFIC TECHNOLOGICAL FORECASTING TECHNIQUES
(QUESTION 27)

Techniques	Number Of Firms Who Have Used For Past 2 Years	Have Used For 2-5 Years	Have Used For Longer Than 5 Years	Plan To Use In The Future	Have Never Used	Have Used But Discarded
a) Extrapolative Approaches	13	9	30	2	87	1
b) Morphological Analysis	4	3	1	4	121	0
c) Scenario Writing	7	5	7	5	109	1
d) Impact Analysis	10	5	12	3	103	0
e) Relevance Analysis	5	1	9	3	113	0
f) Contextual Mapping	0	2	1	3	121	0
g) Normex Reconciliation	0	0	0	3	122	0
h) Delphi Method	4	6	7	6	109	2
i) Soon Charting	0	2	0	3	123	0
j) Technological Mission Analysis	6	4	10	4	102	0

TABLE VI-3

QUESTIONS CONSIDERED BY FIRMS EVALUATING RESEARCH AND DEVELOPMENT PROJECTS (QUESTION 28)

Questions	Yes		No		Missing Data	
	Firms	%	Firms	%	Firms	%
a) Is Research and Development consistent with corporate strategy?	179	91.3	6	3.1	11	5.6
b) Should we invest in the same technologies as our competition?	141	71.9	40	20.4	15	7.7
c) How do we maximize the flexibility of our organization structure in the face of rapid technological change?	132	67.3	43	21.9	21	10.7
d) How can technology transfer best be achieved from Research and Development to manufacturing and marketing?	144	73.5	30	15.3	22	11.2
e) What kind of product/market strategy should we follow?	168	85.7	12	6.1	16	8.2
f) What technical advantages in our products, at what cost, will be needed in the future to give us a substantial competitive advantage?	169	86.2	13	6.6	14	7.1

allocation to the technological forecasting effort in most firms.

Table VI-4 simply emphasizes again the fact that Canadian management has not yet fully recognized the potential of technological forecasting to the future success of their operations. One-hundred and fifty-six firms report having no specific strategy for integrating technological forecasting internally.

Analysis of the data underlying Table VI-5 shows that where technological forecasting is used it is used by firms located in Ontario and Quebec. This is to be expected. However, Table VI-6 is very interesting. Analysis of significant cross-tabulations of technique used vs. industrial classification indicate a significant underrepresentation of manufacturing firms among respondents reporting the use of technological forecasting.

Table VI-7 indicates that firms engaged solely in R & D are less interested in using technological forecasting than those firms whose R & D organization is part of a larger corporate entity. We think that the reason for this is that the majority of firms engaged in R & D as their sole activity do so on a contract basis. Therefore, being at least once removed from market forces which affect their immediate survival, solely R & D organizations have not felt the same incentive to try to mold their own future as market sensitive companies have. They simply do as they are asked by firms contracting their services and honor their contracts per prescribed agreement.

TABLE VI-4

THE NUMBER OF FIRMS WHO HAVE A SPECIFIC STRATEGY FOR INTEGRATING TECHNOLOGICAL FORECASTING INTERNALLY (QUESTION 29)

Plan For Integrating Technological Forecasting	Absolute Frequency Firms	Relative Frequency %
Yes	25	12.8
No	156	79.5
Missing Data	15	7.7
	196	100.0

TABLE VI-5

LOCATION OF FIRM CROSSTABULATED WITH EACH OF THE TECHNOLOGICAL FORECASTING TECHNIQUES

Technological Forecasting Techniques	Location Of Firm
a) Extrapolative Approaches	Not Significant
b) Morphological Analysis	Not Significant
c) Scenario Writing	Not Significant
d) Impact Analysis	Significant at 0.0190
e) Relevance Analysis	Not Significant
f) Contextual Mapping	Not Significant
g) Normex Reconciliation	Significant at 0.0001
h) Delphi Method	Significant at 0.0039
i) Soon Charting	Significant at 0.0001
j) Technological Mission Analysis	Significant at 0.0051

TABLE VI-6

INDUSTRIAL CLASSIFICATION CROSSTABULATED WITH EACH OF THE TECHNOLOGICAL FORECASTING TECHNIQUES

Technological Forecasting Techniques	Industrial Classification
a) Extrapolative Approaches	Significant at 0.0001
b) Morphological Analysis	Significant at 0.0494
c) Scenario Writing	Significant at 0.0001
d) Impact Analysis	Significant at 0.0001
e) Relevance Analysis	Significant at 0.0011
f) Contextual Mapping	Significant at 0.0001
g) Normex Reconciliation	Significant at 0.0001
h) Delphi Method	Significant at 0.0015
i) Soon Charting	Not Significant
j) Technological Mission Analysis	Significant at 0.0001

TABLE VI-7

TYPE OF R & D ORGANIZATION AND THE USE OF TECHNOLOGICAL FORECASTING TECHNIQUES

	Solely R&D			R&D Part Of Corporate Structure		
	Yes	No	Missing	Yes	No	Missing
	Firms					
1) Use Technological Forecasting Technique	3	15	178	67	90	39
2) Use Extrapolative Approaches	3	9	184	49	82	65
3) Use Morphological Analysis	1	10	185	7	116	73
4) Use Scenario Writing	1	10	185	18	106	72
5) Use Impact Analysis	2	9	185	25	98	73
6) Use Relevance Analysis	0	11	185	15	106	75
7) Use Contextual Mapping	1	10	185	2	115	79
8) Use Normex Reconciliation	0	10	186	0	116	80
9) Use Delphi Method	2	9	185	15	109	72
10) Use Soon Charting	0	10	186	2	117	77
11) Use Technological Mission Analysis	2	10	184	18	97	81
12) Have Plans For Integration Of Technological Forecasting	3	15	178	23	141	32

Analysis of data presented on Table VI-8 indicates that the relationship between the technique called technological mission analysis with emphasis of R & D activity (i.e., pure, applied or mixed) showed-up as being significant simply because of the underrepresentation of technological forecasting users in solely R & D structured firms. This same factor coupled with the fact that so few firms plan to use technological forecasting caused the crosstabulation of the variable "firms planning to integrate technological forecasting internally" with the variable "emphasis of R & D activity" to be significant.

As expected, Table VI-9 indicates that market oriented firms are the ones who consider technology of competitors when considering proposed investments in R & D projects. This correlates with the data shown on Table VI-10. Managements who consider technical advantages of products also consider the firm's relationship with existing markets and market share when evaluating R & D projects. Also, managements who consider technical advantages of products are more likely to use technological forecasting technique(s) than those managements who do not consider technical advantage.

D. Summary

Most of the Canadian firms responding to the questionnaire are not using the more sophisticated techniques of technological forecasting and what is more important, from a national point of view, they are not planning to. There has been some acceleration

TABLE VI-8

EMPHASIS OF R & D ACTIVITIES CROSSTABULATED WITH EACH OF THE TECHNOLOGICAL FORECASTING TECHNIQUES

1) Technological Forecasting Techniques	Emphasis (Pure, Applied Mixed)
a) Extrapolative Approaches	Not Significant
b) Morphological Analysis	Not Significant
c) Scenario Writing	Not Significant
d) Impact Analysis	Not Significant
e) Relevance Analysis	Not Significant
f) Contextual Mapping	Not Significant
g) Normex Reconciliation	Not Significant
h) Delphi Method	Not Significant
i) Soon Charting	Not Significant
j) Technological Mission Analysis	Significant at 0.0019
2) Firms Have Plans For Integration Of Technological Forecasting	Significant at 0.0013

TABLE VI-9

TYPE OF R & D ORGANIZATION AND THE CONSIDERATION OF THE TECHNOLOGY OF COMPETITORS WHEN INVESTING

Firms Consider Technology Of Competitors When Investing	Solely R&D	R&D Part Of Corporate Structure
Yes	12	130
No	5	35
Missing Data	179	31
	196	196

TABLE VI-10

TECHNICAL ADVANTAGES OF FIRM'S PRODUCTS CROSSTABULATED WITH FACTORS USED BY FIRMS IN EVALUATING R & D PROJECTS (ONLY STATISTICALLY SIGNIFICANT RESULTS ARE REPORTED)

	Technical Advantages Of Firm's Products
1) Evaluation Factors	
a) Relationship With Existing Market	Significant at 0.0003
b) Market Share	Significant at 0.0118
2) Other	
a) Uses Technological Forecasting Techniques	Significant at 0.0274
b) Uses Extrapolative Approaches	Significant at 0.0054

in use of technological forecasting during the past two years among that group of firms which have been applying technological forecasting for the past two to five years. The underrepresentation of manufacturing firms among respondents reporting the use of technological forecasting may have long run implications for the nature of the general competitive health of Canadian manufacturing companies.

It is interesting to note that in Erich Jantsch's study, Canada showed up both as a country which seemed to lag behind other major countries in the application of technological forecasting at the national level and as a country which felt the need for technological forecasting in the context of national objectives and limitations.[46,47] We are not certain what state-of-the-art exists at the national level or at other governmental levels at the present time, as this was beyond the scope of this study.

We think that the lack of technological forecasting by Canadian industrial organizations, and perhaps by governments at all levels, represents a definite long run disability to the country for three major reasons. Firstly, this means that the decisionmakers who are most responsible for the shape of policies and resource utilization configurations are passive with respect to the future. If Canada wants to be the primemover with respect

---

46. Jantsch, op. cit., p. 310.

47. Ibid., p. 20.

to the shape of its own future, managements in both government and industry need to be aggressive with respect to the future. Secondly, our interviews with top management and data from the questionnaire indicates that the R & D activity of technologically based Canadian organizations is very strongly product oriented. As pointed out by Jantsch, the most important development in both industrial and military environments is the change from an organization which is oriented to product or military services towards a function-oriented organization because the long-range future aspects can be properly dealt with only in terms of functions.[48] Thirdly, the lack of extensive use of technological forecasting philosophy in Canada is a weakness because of the resulting inherent management myopia with respect to R & D activity and project selection. Jantsch makes this point very succinctly.

> "The area of fundamental science and technology is still the battlefield of competing philosophical concepts with respect to the applicability of normative thinking. The widespread negative belief, which finds its principal exponent in Thomas S. Kuhn, is disproven by the growing importance of normative technological forecasting for the guidance of fundamental research institutes with advanced management concepts. Probably one of the most far-reaching consequences of the systematic application of technological forecasting will be a change in nature and an expansion in volume of fundamental research, which will be directed increasingly to answering questions put

48. Ibid., p. 20.

> to it in terms of basic relationships and alternatives and of ultimate potentials and limitations."[49]

Clearly, serious consideration needs to be given to current national policy which seems to reward solely product oriented R & D efforts.

It was the opinion of some management that there needs to be a consolidation of, or at least a central agency for administering, the various efforts taking place throughout Canada in the technological forecasting area. We did not have time to follow this up but the present opinion of knowledgeable individuals is that, at present, there is no one person, group, government agency, or University with enough talent or respect to act as a central management in this arena.

---

49. Ibid., pp. 17-18.

SECTION VII

MANAGEMENT GAMES OR SIMULATION

A. Rationale For Questionnaire

This aspect of management decisionmaking was investigated because of the potential that management games or simulations have with respect to a well designed management development package. If a computer oriented experimental and management development program for R & D project selection decisionmakers emerges as a result of this investigation, it will be necessary to accept or discard the prior hunch that any such program should be independent with respect to any existing corporate computer system(s). In addition, there seems to be a lack of any really reliable data about the use of computers by Canadian managements for anything other than the most fundamental tasks. For example, a typical very general statement was made in a recent article in the Financial Post:

> "At the end of the 1960s, often labeled as the era of the computer, only 2.5% of industrial and commercial facilities were computerized. And the bulk of those data processing activities were devoted to "bread and butter" tasks like payroll, inventory and accounting problems. Advanced applications were a very small part of the total. The industrial and commercial establishment currently devotes only 1% of its total budget to data processing so we conclude

> there is a sizable untapped potential for growth."[50]

This same lack of knowledge in the United States was reported in 1972 and was the object of a survey of the top 152 U.S. corporations, ranked by sales, as listed in Fortune's 500.

> "Despite claim and counterclaim, little is known of either the extent to which simulations are utilized in corporate management development programs or the reactions of the companies that use them."[51]

B. Actual Management Games Or Simulation Portion Of The Questionnaire

The portion of the survey questionnaire pertaining to management games or simulation is shown on the following page.

C. Profile Data

Table VII-1 indicates that 78% of the responding firms use computers in some aspect of their operation. What is surprising is that in early 1974 almost 22% of the responding technologically based Canadian firms, who report some R & D activity, do not use computers for even the "bread and butter" aspects of operations. Given this fact it is not surprising to find that 39 firms, or only 25% of the firms using computers

---

50. Weissmann, Tom, "Tomorrow's Computer: More Raw Power At A Lower Price," The Financial Post, April 13, 1974, p. 22.

51. Marcello, Jerome, and Cribbin, James J., "Whatever Happened To Management Simulation?" Management Review, May, 1972, p. 14.

V. MANAGEMENT GAMES OR SIMULATION

30. Does your firm use computers in any aspect of its operation? Yes_____ No_____

31. Has your firm any experience in adopting and implementing a "decision information system" computerized or other?

a) Computerized Yes_____ No_____

b) Other (please specify) Yes_____ No_____

_____

_____

32. Has your firm ever used a management game or simulation in Research and Development selection and/or Product Development?

Yes_____ No_____

a) If yes, please describe briefly the area(s) in which a game or simulation was utilized.

_____

_____

_____

b) Was the game or simulation computerized? Yes_____ No_____

c) Was it successful? Yes_____ No_____

33. Has your firm ever used a management game or simulation in any part of its planning activity other than Product Development and Research and Development?

Yes_____ No_____

a) If yes, please describe briefly the area(s) in which a game or simulation was utilized.

_____

_____

_____

b) Was the game or simulation computerized? Yes_____ No_____

c) Was it successful? Yes_____ No_____

34. As indicated in the covering letter we are interested in further in-depth analysis in order to build a management game or simulation model that can be used both experimentally and as an aid for helping project managers learn about techniques that are useful in the project selection decision.

a) Would your firm, if selected, be willing to participate in on-site interviews (conducted at our expense)?

Yes_____ No_____

b) If current research is successful, would your firm be willing to participate in such an experimental management game or simulation?

Yes_____ No_____

TABLE VII-1

NUMBER OF RESPONDING FIRMS USING COMPUTERS IN THEIR OPERATIONS

Computers Used	Absolute Frequency Firms	Relative Frequency %
Yes	153	78.1
No	43	21.9
	196	100.0

(39/153 x 100), have had any experience with computerized decision-information systems as shown on Table VII-2.

Data summarizing the experience of managements using noncomputerized decision-information systems is not very definitive as shown on Table VII-3. Of the twelve firms reporting such systems, five did not specify the nature of their information systems while the seven who reported on such experience listed only well established applications.

As shown on Table VII-4, only 20, or about 10%, of the 196 respondents are using management games or simulations to aid decisionmaking in R & D and/or product development. Sixteen of the 20 applications were viewed as being successful and 18 out of 20 were computerized.

Twenty-seven, or about 14%, of the responding firms indicated that they use management games or simulations in areas other than R & D and/or product development. This data, together with a summary of the areas in which games or simulations are used, is presented on Table VII-5. Twenty-four of the 27 applications are viewed as being successful and all are computerized.

In the Marcello - Cribbin study mentioned above, 89 firms, out of the top 152 U.S. corporations ranked by sales as listed in Fortune's 500, responded to a questionnaire. Of these 89 firms, only 37 or about 24%, included simulations as part of their management development programs. In addition, of the 52 firms that did not make use of simulations, as reported in the Marcello and Cribbin study, 14 had at one time or another relied on them

TABLE VII-2

NUMBER OF FIRMS WITH EXPERIENCE IN COMPUTERIZED DECISION INFORMATION SYSTEMS

Experience	Absolute Frequency Firms	Relative Frequency %
Yes	39	19.9
No	137	69.9
Missing Data	20	10.2
	196	100.0

TABLE VII-3

NUMBER OF FIRMS WITH EXPERIENCE IN
NONCOMPUTERIZED DECISION INFORMATION SYSTEMS

Experience	Absolute Frequency Firms		Relative Frequency %	
Yes				
Screening Programs	1		0.5	
Checklists	2		1.0	
Mapi	1		0.5	
Financial Authorization	1		0.5	
Decision Trees	2		1.0	
Not Specified	5		2.6	
		12		6.1
No		109		55.6
Missing Data		75		38.3
		196		100.0

TABLE VII-4

NUMBER OF FIRMS USING MANAGEMENT GAMES
OR SIMULATION R & D AND/OR PRODUCT DEVELOPMENT

Using Games	Absolute Frequency Firms	Relative Frequency %
Yes		
Management Training	5	2.6
Risk Models	2	1.0
Probability Models	2	1.0
Resource Allocation	1	0.5
Investment Models	3	1.5
Marketing Models	5	2.6
Not Specified	2	1.0
	20*	10.2
No	169	86.2
Missing Data	7	3.6
	196	100.0

* 16 out of the 20 games were viewed as being successful while 18 out of the 20 games were computerized

TABLE VII-5

NUMBER OF FIRMS USING MANAGEMENT GAMES OR SIMULATION IN AREAS OTHER THAN R & D AND/OR PRODUCT DEVELOPMENT

Using Games	Absolute Frequency Firms	Relative Frequency %
Yes		
Corporate Model	4	2.0
Marketing	6	3.1
Plant Location	1	0.5
Scheduling	4	2.1
Forecasting	1	0.5
Construction	1	0.5
Investment	2	1.0
Financial Planning	4	2.1
Management Training	2	1.0
Not Specified	2	1.0
	27*	13.8
No	155	79.1
Missing Data	14	7.1
	196	100.0

* 24 of the 27 management games were viewed as being successful and all 27 such applications were computerized

but had discontinued their use.[52]

A comparison of the results of the Marcello and Cribbin study with the results of the study reported on in this section of the report is shown on Table VII-6. Because of the differences in the inherent nature of the universes between the two studies, it is difficult to make statistically meaningful comparisons. However, our judgment is that technologically based Canadian firms are probably as sophisticated in the area of management games or simulations as U.S. corporations. However, in both of these studies the idea that management games or simulations are widely used in refuted as being a myth.

D. Summary

Given the amount of literature and research that has been generated in the area of management simulations and games we were frankly surprised to find such a widespread lack of use of these techniques by management.[53] It is interesting to note that this phenomena exists in the top U.S. corporations as well. We think that the explanation for this may be that, as reported by Marcello and Cribbin, simulations and games are used most frequently by middle and supervisory levels.[54] Top managements

---

52. Ibid., pp. 14-15.

53. See Section VIII, "A Selected Bibliography of Games and Simulations," of this report.

54. Marcello and Cribbin, op. cit., p. 15.

TABLE VII-6

COMPARISON OF THIS STUDY WITH THE MARCELLO AND CRIBBIN INVESTIGATION INTO BUSINESS SIMULATIONS

This Study	Marcello and Cribbin Study
Objectives	
Determine extent of use, management focus, and success of business games or simulations	Determine extent of use, objectives, management focus, and effectiveness of business simulations in large companies
Date of Study	
Reported May 1974	Reported May 1972
Sample Universe	
Approximately 550 different Canadian corporations reporting R & D activity as of the fall of 1973	Top 152 corporations, ranked by sales, as listed in Fortune's 500
Number of Respondents	
196 Firms 35%	89 Firms 59%
Use In R & D and/or Product Development	
20 Firms 10% 80% successful 90% computerized	? ? ? ?
General Use of Games or Simulations	
27 Firms 14% 83% successful 100% computerized	37 Firms 41% 94% successful ?
Primary Management Focus	
100% technical	Only slightly over 30% listed the advantage of illustrating the value of quantitative analytical procedures. About 70% emphasized a behavioral-science orientation

may simply not want to be involved in this kind of in-house activity, because in order to be meaningful for them a greater degree of participation might be required than they think can be or is justified.

However, the majority of top management in Canada seems to think that they are interested in the possibility of increasing company use of management simulations and games. One hundred and one of the 196 firms\ responding to the questionnaire indicated that, yes, they would be interested in participating in an experimental management game if our current and potential research is successful. An executive of one of Canada's leading nationally owned corporations told us that if it was possible to develop a simulation or game that employees of his firm could relate to, that his firm would definitely be interested in such development. His particular company had been interested for some time in management simulations but had not had the personnel resources available for such development. Herein lies the real problem for our future research to which we have already begun to address our thinking. How does one construct a management game or simulation, aimed at improving the decisionmaking processes of Canadian R & D project selection decisionmakers, that is general enough to cover a broad spectrum of industries but specific enough so that individual management(s) can meaningfully relate to it?

SECTION VIII

A SELECTED BIBLIOGRAPHY OF GAMING AND SIMULATION

A. Rationale

The words "management simulation" and "management game" often connote the same meaning. Because of the potential of the technique(s) for use in any management development program, the authors of this report decided that a thorough review of the literature was necessary before any reliable assessment of the state-of-the-art could be made. The bibliography which is included in this section of the report represents all of the literature known to be available at or to the library at the University of Alberta.

As indicated by the bibliography, a complete library search of available literature was undertaken. Each article or book was reviewed with the explicit objective of trying to uncover meaningful information with respect to specific results, experiences, and suggestions for improvement made by the various authors. A special "I.T.C. Bibliography Reporting Form" was designed, as shown on the next page, to summarize pertinent data obtained from each reference. Individual references were placed on computer file and, as shown, the final computer printout resulted in bibliography organized by both author and subject.

I.T.C. BIBLIOGRAPHY REPORTING FORM

AUTHOR	TITLE	
SOURCE		
YEAR	PAGES	INDEX CODE
LIBRARY CALL NUMBER	SUBJECTS	
CODE		
SUBJECT (OBJECTIVE, CONTENT, ETC.)		
PROCEDURE (METHODOLOGY)		
RESULTS (EXPERIENCES, SUGGESTED MODIFICATION, ETC.)		

The following is a summary of what were considered to be the most important results of the literature review. It is not the purpose of this report to present the pros and cons of the use of management games and simulations.

B. Summary

As indicated in Section VII, management has simply not adopted the use of games and simulations as supporters of the new science of management decision have suggested they would. Although there has certainly been a revolution in the teaching of the art or science of management and organization within schools of Business Administration in North America, this "new found" philosophy has yet to really manifest itself in top management decisionmaking. Present indications are that traditional decisionmaking methods have simply not been replaced by modern heuristic problem-solving techniques as applied to training human decisionmakers and in the construction of heuristic computer programs, in the degree predicted by academics such as Herbert Simon.[55] As a matter of fact, our own research and actual experience has shown that management is extremely slow to adopt scientific methods for improving, training, or aiding management in the art and/or science of decisionmaking.[56]

---

55. Simon, Herbert A., The New Science of Management Decision, Harper and Row, New York, 1960, p. 8.

56. Maher, P. M., Harnden, B. M., and Miyagawa, R., "Factors Affecting The Adoption Of A Quantitative Technique For Forest Fire Detection Systems Design," A paper summarizing the results of this research is currently in the final stages of preparation.

Therefore, it was not surprising to find that the most explicit statements about results, experiences, and suggestions for improvements with respect to management games or simulations exist in reports of formal research efforts, particularly in dissertations, and in educational journals reporting classroom experiences.[57]

The use of management games or simulations as part of a management development program implies that this approach at least complements conventional teaching methods. As a matter of fact, the literature strongly supports the contention that gaming and simulation are important supplemental educational aids when supported by other conventional methods, i.e., films, lecture, cases, slides, group participation, etc. Coleman, Fennessey, Heinkel, Moore, Paploizos, Raia, and Tait, all conclude that gaming and simulation are not necessarily superior methods of instruction and should not be used alone. This conclusion supports our own teaching experience. There was only one semi-dissenting view to this conclusion found in the literature. Harpstrite, in a dissertation completed at Michigan State University in 1972, found that both teachers and students were positively disposed to simulations and games and negatively disposed to lecture-discussions.

Several authors direct their attention to the learning aspect of games and simulation.

---

57. For expediency, specific references noted will be referred to only by the last name of the author listed in the "Selected Bibliography on Gaming and Simulation Organized By Author" which is included at the end of this section of this report.

C. R. Anderson, in a study at the University of Maryland in 1969 designed to determine whether a simulation-learning game is more effective than conventional classroom approaches in learning to acquire factual information about consumer credit, sources, and risks, reported that there was no significant differences found in the learning of factual information or the ability to select and sign an optimal credit contract, but that learning to compare alternative sources of credit was greater when simulation was used rather than conventional methods. We think that perhaps this is a significant fact to consider when teaching managers, since the backbone of the science of decision-making consists of selecting between alternative courses of action.

R. D. Ashmum, in a thesis completed at the University of Minnesota in 1966, found that there was no significant difference in the effectiveness of a non-computer business game in teaching post high school business problem classes when compared with conventional lecture-discussion-problem-solving methods.

S. S. Boocock, in a thesis completed at Johns Hopkins University in 1966, discusses and presents empirical evidence pertaining to the effects of games on student learning with respect to motivation, vicarious experience, intellectual learning, attitude change, and differential effects on different types of students. The primary contribution of this study is a zeroing in on the measurement problem with respect to amount of learning. Since most measures depend on the ability of the

participant to "express" himself, it is suggested that less participant-dependent measures such as systematic observation during playing sessions and analysis of data produced in the game itself might circumvent some of the measurement problems.

L. L. Steinmetz and R. J. Patten studied the use of gaming as a training device for lower ranking management and rank-and-file personnel. They concluded that the gaming technique has a large-positive-influence upon the trainee, a definite learning-reinforcing effect, and that fundamental-mechanistic procedures are made meaningful. This latter conclusion, if correct, is important if one of the objectives of a management training program is to teach technique.

G. L. Thorpe points out that as of April 1971, there was no research upon which to state that the use of simulation enhances critical thinking.

An important aspect of the use of management games or simulations as an aid to learning is the affect of these techniques on the attitude of participants. We think that this aspect is particularly relevant when dealing with top management because "attitude" is an important component of management's willingness to adopt more scientific methods of decisionmaking.

C. C. Abt indicates that games are effective teaching and training devices for students of all ages in many different situations because they are highly motivating.

In a joint paper, Boocock and Coleman show that analysis of experimental data indicates that players are highly motivated, acquire specific information that each game teaches, and that they gain a broader perspective on the social situation simulated in a game including confidence in their own ability to act.

A. D. Christian, in a study of the effects of educational game experience upon the attitudes of Job Corp trainees, found that significant attitude changes resulted and that game activities affected attitudes of students towards instructors as well.

D. W. Conrath, in an analysis of the experience factor in experimental gaming behavior, reported that the differential effects of time for reflection and past experience is not clear, but that a period of reflection on the environment enhances the probability of subjects behaving in a jointly rational manner. This may support our own thinking with respect to the development of a game or simulation, for improving decisionmaking of R & D project selection decisionmakers, that managements with different day to day organizational experiences can relate to. The key is to focus on the fundamental structure of prototype problems in R & D decisionmaking rather than on specific industry oriented situations when developing a game or simulation. It may be possible to develop a modular package that can be readily tailor-made to fit various companies and/or industry and government operations. Conventional educational tools, as an integral part of the management development program, can be used to enhance the feeling by participants that the game

environment does, in fact, resemble the one in which they operate.

R. Stadsklev, in a comparative analysis of simulation, gaming and lecture discussion methods, reported that attitudes and values of participants are more influenced by simulation as opposed to lecture than factual learning is.

J. A. Steger, when discussing a business game developed for undergraduates, points out that the results of his study indicate enhanced motivation and learning, (of participants), as measured by a final report.

One of the primary reasons for the review of the literature on gaming and simulation was to evaluate the appropriateness of the technique(s) when used as a tool for extending fundamental research into the adoption of more quantitative and/or scientific approaches for decisionmaking, in particular R & D project selection decisionmaking. Indeed, the major thrust of future research needs to contain this component. The fundamental problem is how to wed the dual teaching-research objective.

Babb, et. al., investigated the potential of business gaming methods in research. Their conclusions tend to be weak but indicate that business gaming is potentially promising for investigating the role of information in complex decisionmaking, the benefits of additional information, and the affect of organizational variables on decisionmaking. This is an important conclusion with respect to trying to convey and measure the use

of and contribution of information derived from technological forecasting on research and development decisions. We think that the philosophy behind technological forecasting needs to be transmitted to management. Our interviews indicated that even the most sophisticated management tend to take very self-circumspecting viewpoints even though they are familiar with technological forecasting techniques.

Barringer and Whaley report that, although it is a general purpose tool, gaming is not maximally effective for all possible purposes in the same structural format.

Denhaam, in a study of the factors which strongly affect the positive growth of an R & D project, reports that dynamic business models are particularly useful in the area of studying policy alternatives under changeable conditions where growth is an important factor.

By asking the question, "What is it that makes an experiment realistic?", Drabek and Haas seek to recast previous discussions focused on "realism versus artificiality." It is suggested that relationships between variables may vary under different experimental conditions. The degree of realism is used as a means of identifying experimental characteristics. This analysis of the concept of realism provides a meaningful alternative for future synthesis of small group research, both field and laboratory. Characteristics of a research method labeled "realistic simulation" are identified.

McGregor and Baker in an article critiquing a new and sophisticated management game of potential relevance to public administrators, called GREMEX (Goddard Research Engineering Management Exercise), suggest that the parallels of the management situations in GREMEX with many actual situations indicate that the exercise might be used as a research tool for investigating group management.

Streufert and Kliger describe an experimental simulation used as a method for measurement of integration and response patterning in group decisionmaking, including tactical, negotiation, economic, intelligence, and other potential components.

At this point it is worth articulating how we visualize using a management game or simulation on an experimental basis with respect to R & D project selection decisionmaking. The key question of course is: "What is the experimental apparatus going to be designed to measure?" Thomas E. Clarke does a good job of classifying the recent literature concerned with project selection and evaluation.[58] He lists the main classes of literature pertinent to the subject as being:

1. Description of techniques or mathematical models designed by management scientists for use by research managers.

---

58. Clarke, "Project Selection," op. cit., p. 2.

2. Critiques, discussions, descriptions, or evaluations of the proposed techniques or models.

3. Descriptions of the testing of suggested techniques or models in a real-time situation in an industry.

It is the latter category, i.e., class 3, that is of interest here.

Examination of the pertinent literature and work contained in the bibliography in Clarke's paper as well as publications contained and forthcoming in the journal "Management Science" subsequent to the publication of Clarke's work, indicates that two philosophically different approaches to "real-time" research in the R & D project selection and evaluation exist. The first approach focuses on measurement of the value of different project selection models and mathematical techniques for R & D project selection. Souder's recent publications reflect this emphasis.[59,60] The second approach focuses on measurement of the factors affecting management's willingness to adopt quantitative techniques for

---

59. Souder, William E., "Utility and Perceived Acceptability of R & D Project Selection Models," Management Science, August, 1973, pp. 1384-1394.

60. Souder, William E., "Analytical Effectiveness of Mathematical Models For R & D Project Selection," Management Science, April, 1973, pp. 907-923.

decisionmaking.[61,62] While recognizing the importance of the first approach, the principal authors of this report believe that extending the knowledge pertaining to "the willingness to adopt factors" is the most important facet of research, with respect to R & D decisionmaking, that can be undertaken at the present time. This study seems to substantiate the fact that the real question with respect to management decisionmaking in general is not, "Which techniques should be used?", but, "Why are managers, for example R & D project decisionmakers, not willing to adopt scientific decisionmaking techniques to a much greater degree?" As the adoption process is better understood, the degree of usefulness of different techniques becomes much more meaningful. Therefore, it is our opinion that any management simulation or game resulting from this research should be designed to extend knowledge with respect to the "adoption process."

One of the basic reasons for the literature review on management simulations and games was to search for suggestions for and suggested improvements in methods of application or design of these tools. The literature is severely lacking in this regard. The best applicable thoughts are summarized below.

D. E. Calvert suggests that information gathering in a game situation is made to seem too easy and that quantitative factors are over emphasized. This poses an interesting question.

---

61. Maher, P. M., and Rubenstein, A. H., op. cit.

62. Maher, P. M., Harnden, B. M., and Miyagawa, R., op. cit.

"How does one design a simulation or game to teach technique and enhance management willingness to adopt more elaborate or scientific decisionmaking methods and at the same time down-play the quantitative aspects?"

W. H. Kelly's Ph.D. dissertation examined the effectiveness of educational games in teaching. His recommendations are:

1. Clearly state educational objectives for the game.
2. Keep the game relatively short.
3. Keep the rules simple.
4. Utilize role-playing.
5. Critique the end of each round to consolidate the knowledge gained.

A. F. Haseley found that lagging the flow of competitive data substantially affected profitability, attained by real-life managers of agricultural food processing and marketing firms, when playing the U.C.L.A. Executive Game No. 3.

S. J. Drumheller maintains that games should be geared to the active needs (per Maslow) of the participants. We interpret this suggestion as being potentially important and that it can be construed as; "Do not use a game or simulation aimed at top management at levels of middle management or below." As a matter of fact, the authors of this report have had experience which seems to substantiate this fact.

D. Croy reported on SOLID (Simulation of Life Insurance Decisions), a computer simulation game used by Pacific Mutual

Life, Los Angeles, as an experimental tool in the training of administrative, actuarial, and investment personnel. In his report he criticized SOLID because it did not respond to factors expected to produce results in real life.

The summary of the literature and discussion presented above leads to the following conclusions.

1. Management games or simulations need to be supported by other types of conventional educational aids when used in a formal management development program.

2. Management games or simulations designed to teach technique and to emphasize the comparison of alternative courses of action may improve learning when included as part of a well designed management development program.

3. There seems to be no question about the fact that participation in games or simulations does have an affect on the attitude and motivation of participants. Naturally, designers of such games or simulations would like to make certain that positive effects will result.

4. With the application of some creativity, innovation, and imagination, management games and simulations can be useful research tools for extending fundamental knowledge about the use of quantitative techniques by R & D project selection decisionmakers. The research design should focus on extending knowledge

about factors affecting the willingness of management to adopt such techniques rather than focus on the effectiveness of a particular technique or techniques per se.

5. The challenges in the design of a simulation or game, to be used in an experimental and management development program for research and development project selection decisionmakers, lie in the fact that what seems to be desirable is a game or simulation that is explicit with respect to objective, short, simple, computerized and interactive, that emphasizes the difficulty of information gathering while at the same time it monitors the flow of data derived from the use of quantitative decisionmaking techniques in such a manner that the value of information derived from such techniques is adequately protrayed. In addition, to be most useful the game or simulation needs to be highly flexible and readily adaptable both horizontally (by industry, company, and government agency) and vertically (by level of management). The environment needs to be manipulated in an unobtrusive manner so that fundamental data with respect to a decisionmaker's willingness to adopt quantitative decisionmaking techniques can be extracted without the participants' knowledge.

C. Bibliography

A selected Bibliography on Gaming and Simulation organized first by author and then by subject is presented on the following pages.

A SELECTED BIBLIOGRAPHY

ON

GAMING AND SIMULATION

UNIVERSITY OF ALBERTA

MARCH 1974

TABLE OF CONTENTS

A SELECTED BIBLIOGRAPHY

ON

GAMING AND SIMULATION

ORGANIZED BY AUTHOR

Abt, C.C. An Education System Planning Game . Educational Resources Information Center, 1965.

Abt, C.C. "Games and Simulation." Paper presented to Abington Conference on New Directions in Individualizing Instruction, April 1967.

Abt, C.C. Serious Games . New York: Viking Press, 1970.

Acer, J.W. Business Games: A Simulation Technique . Bureau of Labor and Management. University of Iowa, 1960.

Ackoff, R.H., and Clark D.F. "Report on Some Organizational Experiments." Operations Research 7 (May 1959): 279-293.

Adair, C.H.; Agarwal, A.; Hansen, D.N.; and Rayner, G.T. Two Simulated Inquiry Environments A Social Simulation Game and a CAI-Based Information Retrieval System . CAI Center Technical Memorandum. Tallahassee: Florida State University, 1970.

Adams, R.H. and Jenkins, J.L. "Simulation of Air Operations with the Air-Battle Model." Operations Research 8 (September-October 1960): 600-615.

Alderfer, C.P. "Effect of Individual Group and Intergroup Relations on Attitudes Toward A Management Development Program." Journal of Applied Psychology 55 (4) (August 1971): 302-311.

Amos, J.M. "Educational Aspects of Business Games." Journal of Business Education 40 (November 1964): 61-62.

Anderson, C.R. "The Effectiveness of a Simulation Learning Game in Teaching Consumer Credit To Senior High School Students in Comparison to a Conventional Approach to Instruction." Thesis, University of Maryland, 1969.

Anderson, D.W. "Game That Teaches Production Control Techniques (Managram)." Office 55 (May 1962): 132.

Armstrong, R.H.R. and Taylor, J.L., eds. Instructional Simulation Systems in Higher Education . England: Cambridge Institute of Education, 1970.

Ashmun, R.D. "The Effectiveness of a Non-Computer Business Game in Teaching Post-High School Business Problem Classes." Thesis, University of Minnesota, 1966.

Attig, J.C. "Use of Games as a Teaching Technique." The Social Studies 58 (January 1967): 25-29.

Avedon, E.M. and Sutton-Smith, B. The Study of Games . New York: J. Wiley, 1971.

Babb, E.M. and Eisgruber, L.M. Management Games for Teaching and Research . Chicago: Educational Methods Inc., 1966.

Babb, E.M., et al. "Potential of Business Gaming Methods In Research." Journal of Business 39 (October 1966): 465-472.

Baker, P.F. "GPEMEX: Goddard Research and Engineering Management Exercise." Educational Technology 10 (January 1970): 61-63.

Banks, M.H.; Groom, A.J.R.; and Oppenheim, A.N. "Gaming and Simulation in International Relations." Political Studies 16 (February 1968): 1-17.

Barich, N.W. and Self, F.H. "Operational Gaming Simulation With Application to a Stock Market." Management Science 15 (June 1969): B530-B541.

Barringer, R.E. and Whaley, B. "MIT Political Military Gaming Experience." Orbis 9 (Summer 1965): 437-458.

Barton, R.F. A Primer On Simulation and Gaming . Englewood Cliffs: Prentice Hall Inc., 1970.

Bass, B.M. "Business Gaming for Organizational Research." Management Science 10(3) (April 1964): 545.

Beals, P.F. "Games and Simulation." Grade Teacher 88 (March 1971): 94.

Becht, J.E., et al. Mantrap: Management Training Program . Centre For Research in Business and Economics. Texas: University of Houston, 1963.

Bibliography of Games-Simulations For Teaching Economics and Related Subjects . New York: Joint Council on Economic Education, 1968.

Bickham, I.B. "A Marketing Management Game Designed with Particular Emphasis on Channels of Distribution." Thesis, University of Texas, 1965.

Bloomfield, L.P. and Padelford, N.J. "Three Experiments in Political Gaming." American Political Science Review 53 (December 1959): 1105-1115.

Blouet, B.W. and Buckwalter, D. "Operational Games for Geographers: Economic Development Problems on an Imaginary Caribbean Island." Journal of Geography 70 (November 1971): 487-491.

Boardman, R. "Theory and Practice of Educational Simulation." Educational Research 11(3) (June 1969): 179-184.

Boocock, S.S. "The Effects of Games With Simulated Environments Upon Student Learning." Thesis, Johns Hopkins University, 1966.

Boocock, S.S. "An Experimental Study of the Learning Effects of Two Games With Simulated Environments." American Behavioral Scientist 10(2) (October 1966): 8-17.

Boocock, S.S. and Coleman, J.S. "Games With Simulated Environments in Learning." Sociology of Education 39 (Summer 1966):215-236.

Braasch, J.M. "Business Games Programmed Players, and Individual Decision Making Profiles." Thesis, University of Minnesota, 1966.

Brammer, N.D. "A Comparative Investigation of the Use of Digital Computer System Simulation in Business Organizations." Thesis, University of Iowa, 1971.

Broom, H.N. Business Policy and Strategic Action . Englewood Cliffs: Prentice Hall Inc., 1969.

Brophy, P., et al. A Library Management Game: A Report on a Research Project . University of Lancaster Library. Lancaster, England: University of Lancaster, 1972.

Brotman, L. and Seid, B. "Digital Simulations of a Massed-Bomber, Manned-Interceptor Encounter." Operations Research 8 (May-June 1960): 421-423.

Burch, J.G., Jr. "Business Games and Simulations Techniques." Management Accounting 51 (December 1969): 49-52.

Burnett, J.D. "Component Curve Analysis of Student Performance on a Computer-Based Simulation Game." Alberta Journal of Educational Research 17(2) (June 1971): 117-128.

"Business Games at High Speed." Industrial Canada 62 (August 1961): 28-30.

"Business Games For Fun and Profit." Industry Week 167 (July 6,1970):28-33.

Caldwell, J.C. "An Inquiry into Business Gaming as a Pedagogidal Technique in Accounting Education." Thesis, University of Alabama, 1970.

Calvert, D.E. "Pros and Cons of Management Games." Educational Technology 12 (June 1972): 62-4.

Carlson, J.G. and Misshauk, M.J. Introduction to Gaming: Management Decision Simulations . New York: J. Wiley, 1972.

Carson, J.F. "Business Games: A Technique For Teaching Decision-Making." Management Accounting 49 (October 1967): 31-35.

Chapin, J.R. "Simulation Games." Social Education 32 (December 1968): 798-791.

Charles, C.L. and Stadsklev, R., eds. Learning With Games: An Analysis of Social Studies, Educational Games and Simulations . Education Resources Information Center (Social Studies/Social Sciences Education), 1973.

Cherryholmes, C.H. "Some Current Research or Effectiveness of Educational Simulations: Implications for Alternative Strategies." American Behavioral Scientist 10(2) (October 1966): 4-7.

Christian, A.D. "A Study of the Effects of Educational Game Experience Upon the Attitudes of Job Corps Trainees." Thesis, University of Texas at Austin, 1971.

Clark, D.F. and Ackoff, R.L. "Report On Some Organizational Experiments." Operations Research 7 (May 1959): 279-293.

Coghill, M.A. Games and Simulations in Industrial and Labor Relations Training . New York: State University of New York, and Ithaca: Cornell University, September 1971.

Cohen, K.J. and Rhenman, E. "The Role of Management Games in Education and Research." Managment Science 7(2) (January 1961): 131.

Cohen, K.J., et al. "Carnegie Tech Management Game." Journal of Business 33 (October 1960): 303-321.

Coiner, L.M. "Management Games: Win By Learning." Administrative Management 33. (March 1972): 16.

Coleman, J.S. "Academic Games and Learning." National Association of Secondary School Principals Bulletins 52 (February 1968): 62-72.

Coleman, J.S. "Learning Through Games: Opinions Differ." NEA Journal 56 (January 1967): 69-70.

Coleman, J.S. The Role of Modern Technology in Relation to Simulation and Games For Learning . Washington: Academy for Educational Development Inc., 1970.

Collett, M.J. "Simulation as a Management Development Tool." Personnel Administration 25 (March 1962): 48-51.

Collins, J.F. and Paulsen, T.D. The Modeling of Human Intelligence as Demonstrated in the Game of DIPLOMAT . Springfield: National Technical Information Service, 1970.

Computer Simulation: A Bibliography of Selected RAND Publications . Santa Monica: RAND Corporation, 1971.

"Computers and Management Games." Personnel Journal 40 (July-August 1961): 123.

Conrath, D.W. "Experience As a Factor In Experimental Gaming Behavior." Journal of Conflict Resolution 14 (June 1970): 195-202.

Craft, C.J. and Kibbee, J.M. "Management Games." Canadian Chartered Accountant 79 (August 1961): 135-142.

Craig, R.L. and Bittel, L.R., eds. Training and Development Handbook . New York: McGraw-Hill Book Co., 1967.

Crawford, M.P. "Dimensions of Simulations." American Psychologist 21(8) (1966): 788-796.

Crawford, M.P. "Simulation in Training and Education." Human Resources Research Office Professional Paper, 1967.

Croft, J.D. "The Development and Evaluation of a Geographical Simulation Game Involving the Arkansas River Project." Thesis, University of Tulsa, 1971.

Croy, D. "Computer Games [Solid]." Best's Review (Life/Health Insurance Edition) 70 (October 1969): 10-12.

Cruickshank, D.R. "The Notions of Simulations and Games: A Preliminary Inquiry." Educational Technology 12(7) (July 1972): 17-19.

Culbertson, J., et al. The Design and Development of Prototype Instructional Materials for Preparing Educational Administrators. Final Report . University Council for Educational Administration, 1968.

Dale, A.G. "Management Decision Tester: Computer Used to Simulate Operations of Small Business." Computers and Automation 11 (October 1962): 47-49.

Davis, K.R. "Systems Implementation: A Gaming Approach." Thesis, North Texas State University, 1972.

Dav, P.L. Marketing in Action: A Decision Game , rev. ed. Homewood, Ill.: R.D. Irwin, 1968.

Dav, P.L. Marketing in Action: A Dynamic Business Decision Game . Homewood, Ill.: R.D. Irwin, 1962.

Dav, R.P. and Lymberopoulas, P.J. "Decision Game: Progress and Prospects." Southwestern Social Science Quarterly 42 (December 1961): 250-258.

Deacon, A.P.L. "Selected Bibliography; On Simulation Gaming and Related Topics." AMA Management Report No. 55 . American Management Association, 1961.

Deacon, A.P.L., Jr. Simulation and Gaming: A Symposium . New York: American Management Association General Management Division, 1961.

Decaroli, J. "Simulation Games." Social Education 36 (May 1972): 541-543.

Deep, S.D., et al. "Some Effects on Business Gaming of Previous T-Group Affiliation." Journal of Applied Psychology 51 (October 1967): 426-431.

Demak, L.S. and Devorkin, L. Games and Simulations: An Approach to Meaning Through Participation. Ideas in Motion . Detroit: Wayne County Intermediate School District, 1969.

Denhaam, A.E. "Dynamic Business Models a Tool to Meet New Business Challenges." Management Accounting 49 (May 1968): 3-11.

Dennick, W.H. and Olanie, F.X., Jr. "Bank Management Game [Simulated Operation With Aid of IBM 650 Computer]." Bankers Monthly 77 (September 1970): 56-60.

Des Jardins, R.B. "An Investigation of Decision Systems in a Complex Management Game." Thesis, University of North Carolina at Chapel Hill, 1965.

Dill, W.R. and Doppett, N. "The Acquisition of Experience in a Complex Management Game." Management Science 10(1) (October 1963): 30-46.

Dill, W.R.; Jackson, J.R.; and Sweeney, J.W., eds. Proceedings of the Conference on Simulation Games . New Orleans: Tulane University, 1961.

Dillman, D.H. and Cook, D.L. Simulation in the Training of R&D Project Managers . Educational Program Management Center. Columbus: The Ohio State University, 1969.

Dolbear, F.T., Jr., et al." Simulation Policy Game For Teaching Macroeconomics." American Economic Review: Papers and Proceedings 58 (May 1968): 458-468; 483-491.

Doney, L.D. "Management Simulations: The Next Step in Business Schools." Journal of Educational Data Processing 7, No. 6, (1970): 23-28.

Doob, P.A. Prospects for Simulation Gaming in Health Planning and Consumer Health Education . Department of Health Administration, School of Hygiene and Public Health. Baltimore: Johns Hopkins University, 1972.

Drabek, T.E. and Haas, J.E. "Realism in Laboratory Simulation Myth or Method." Social Forces 45 (March 1967): 337-346.

Dresher, M. Games of Strategy: Theory and Applications . Englewood Cliffs: Prentice Hall Inc, 1961.

Drumheller, S.J. "Curriculum Making as a Game Designing Task." Educational Technology 12(5) (May 1972): 13-17.

Duff, T.B. "Simulation Games; A Basic Business Natural." Business Education Forum 26 (March 1972): 65-66.

Duke, R.D. Bibliography for Gaming in Urban Research . The Institute for Community Development and Services. East Lansing, Mich.: Michigan State University, 1963.

Duke, R.D. Gaming Simulation in Urban Research . The Institute for Community Development and Services. East Lansing, Mich.: Continuing Education Services, Michigan State University, 1964.

Duke, R.D. and Schmidt, A.H. Operational Gaming and Simulation in Urban Research: An Annotated Bibliography . The Institute for Community Development and Services. East Lansing, Mich.: Michigan State University, 1965.

Dyck, J.J.J. van. "Understanding of the Organization Process Via the Management Game." Journal of Management Studies 5(3) (October 1968): 338.

Edwards, K.J. The Effect of Ability Achievement, and Number of Plays on Learning from a Simulation Game. Report No. 115 . Center for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, September 1971.

Edwards, K.J. Student's Evaluations of a Business Simulation Game as a Learning Experience. Report No. 121 . Centre for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, December 1971.

Edwards, K.J., et al. Games and Teams: A Winning Combination. Report No. 135 . Center for the Study of the Social Organization of Schools. Baltimore: Johns Hopkins University, July 1972.

Filoart, T. and Searle, N. "Business Games Off Shelf." Simulation 20, No. 2, (February 1973): 63.

Filon, S. "Management Games." Operational Research Quarterly 14(2) (June 1963): 137-149.

Flder, C.D. "Problems in the Structure and Use of Educational Simulation." Sociology of Education 46 (Summer 1973): 335-354.

Ellis, N.D. "The Relationship Between Identifiable Attributes and Decision-Making Ability of Purchasing Personnel as Measured by the Results of a Management Game." Thesis, North Texas State University, 1973.

Engel, A. and Maes, W.R. "Teaching Personality Theory: A Games Approach." Counselor Education and Supervision 11(1) (September 1971): 24-28.

Ewing, S. "Selected Effects of Creativity and Risk Taking on Business Game Behavior: An Experimental Investigation." Thesis, Texas Technological College, 1973.

Feldt, A.G., et al. CLUG: Community Land Use Games: Players Manual with Selected Readings . New York: Free Press, 1972.

Fennessey, G.M., et al. Simulation, Gaming and Conventional Instruction: An Experimental Comparison . Center for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, 1972.

"Games Are Serious Business." The Canadian Personnel and Industrial Relations Journal 15 (November 1968): 41.

"Games Men Play." Monetary Times 135 (September 1967): 31-33.

Gearon, J.D. "Labor vs. Management: A Simulation Game." Social Education 37 (October 1973): 514-515.

Gearon, J.D. "War or Peace: A Simulation Game." Social Education 30 (November 1966): 521-522: 31 (May 1967): 383-387.

Geisler, M.A. and Steger, W.A. "How To Plan For Management In New Systems." Harvard Business Review 40 (September 1962): 103-110.

Griffin, C.F. The Crisis Game: Simulating International Conflict . Garden City, N.Y.: Doubleday, 1965.

Goldhamer, H. and Speier, H. "Some Observations on Political Gaming." World Politics 12 (October 1959): 71-83.

Goodman, F.F. "The Inter-Community: An Experiment in Simulation-Gaming." Thesis, University of California, 1968.

Graham, P.G. and Gray, C.F. Business Games Handbook . New York: American Management Association, 1969.

Gray, C.F. "A Comparison of Performance and Selected Personality Traits of Participants in a Total Enterprise Business Game." Thesis, University of Oregon, 1966.

Gray, J.,; Willingham, J.; and Johnston, K. "Business Game For Introductory Course In Accounting." Accounting Review 38 (April 1963): 336-346.

Greene, J.F. and Sisson R.L. Dynamic Management Decision Games . New York: J. Wiley, 1959.

Greenlaw, P.S. and Frey, M.W. FINANSIM: A Financial Management Simulation . Scranton: International Textbook Co. 1967.

Greenlaw, P.S. and Hottenstein, M.P. PROSIM: A Production Management Game . Scranton: International Textbook Co., 1969.

Greenlaw, P.S. and Kniffin, F.W. MARKSIM: A Marketing Decision Simulation . Scranton: International Textbook Co., 1964.

Greenlaw, P.S.; Herron, L.W.; and Rawdon, R.H. Business Simulation in Industrial and University Education . Englewood Cliffs: Prentice Hall Inc., 1962.

Griffen, C.H. and Williams, T.H. "Simulation in Business Education." Accounting Review 39(1) (January 1964): 160.

Haack, H.O. and Peterson, G.L. "Games for Simulating Urban Development Process." American Society of Civil Engineers Proceedings 97(UP2) (December 1971): 149-163.

Harpstrite, J.J. "An Analysis of Selected Simulation Games and the Assessment of the Subjective Feelings of Students and Teachers Who Use Simulation Games in Social Studies Instruction." Thesis, Michigan State University, 1971.

Hart, J.T. "Gaming as a Research Tool in International Relations." Thesis, American University, 1967.

Haseley, A.F. "Information and Decision Making in a Management Game." Thesis, Purdue University, 1966.

Hausrath, A.H. Venture Simulation in War, Business and Politics . New York: McGraw Hill , 1971.

Hawkes, R. "Computer Simulates Executives Problems (Lockheed's Aerospace Business Environment Simulator)." Aviation Week and Space Technology 76 (June 18, 1962): 87-91.

Heinkel, O.A. "Evaluation of Simulation as a Teaching Device." Journal of Experimental Education 38 (Spring 1970): 32-36.

Helmer, O. Multipurpose Planning Games . Middletown, Conn.: Institute for the Future, Riverview Center, December 1971.

Helmer, O. and Bickner, R.E. How to Play SAFE: Book of Rules of the Strategy and Force Evaluation Game. Santa Monica: RAND Corporation, November 1961.

Henderson, B.G. and Gainer, W.G. "Assessment of Selected Simulations and Games for the Social Studies." Social Education 35 (May 1971): 508.

Henry, C. "Market Games with Indivisible Commodoties and Non-Convex Preferences." Review of Economic Studies 39 (January 1972): 73-76.

Herron, L.W. Executive Action Simulation . Englewood Cliffs: Prentice-Hall Inc., 1960.

Hogan, A.J. "Simulation. An Annotated Bibliography." Social Education 32 (March 1968): 242-244.

Hoggat , A.C., ed. "1973 Winter Simulations Conference." Proceeding of the Annual Winter Simulation Conference, Sixth . January 17-19, 1973.

Homan, K.V. and Burns, E.M. "Do Rather Than Drill in General Business." Journal of Business Education 44 (March-April 1969): 233-235, 288-291.

Honegger, G.D. "A Business Game Approach To Market Planning." Thesis, Purdue University, 1969.

Horn, R.E. and Zuckerman, D.W. "Getting into Simulation Games." Media & Methods 9 (November 1972): 65.

House, P. Development of Metropolitan (City III) Model. Final Report . Washington: Environmetrics Inc., 1970.

House, P.W., et al. National Gaming Council . Washington: Envirometrics Inc., April 17, 1970.

Hunt, J.G. "Leadership Style Effects at Two Managerial Levels in a Simulated Organization." Administrative Science Quarterly 16 (December 1971): 476-485.

Hutte, H. "Decision-Taking in a Management Game." Human Relations 18 (February 1965): 5-20.

"In Business Education the Games the Thing." Business Week (July 25, 1959): 56-58.

Inbar, M. "The Differential Impact of a Game Simulating a Community Disaster and Its Implications for Games with Simulated Environment." Thesis, Johns Hopkins University, 1966.

Isaacs, R. Differential Games: A Mathematical Theory with Applications to Warfare, and Pursuit, Control and Optimization . New York: J. Wiley, 1967.

Iverson, R.W. MIDSIM: The Maxwell International Development Simulation . Continuing Center for the Public Service. Syracuse: Syracuse University, 1971.

Jensen, B.T. "Business Games for Executive Training." Advanced Management-Office Executive 2 (June 1963): 13-18.

Jensen, I.M. Simulation/ Games. A Selected Bibliography for the Use of Educators/Administrators . Merrill Library and Learning Resources Program. Logan: Utah State University, 1971.

Johnson, R.R. DATACALL: A Computer Based Simulation Game for Teaching Research Strategy . Department of Psychology. Richmond, Ind.: Earlham College, September 1971.

Kasperson, P.E. "Games as Educational Media." Journal of Geography 67 (October 1968): 409-422.

Kelly, W.H. "Are Educational Games Effective in Teaching?" Agriculture Education Magazine 43 (November 1970): 117.

Keys, J.B. "An Investigation of the Type of Managerial Behavior Elicited by Business Games by the Use of the Critical Incident Method." Thesis, University of Oklahoma, 1970.

Khan, A. and Levasseur, P. "Use of Gaming as a Technique for Training Educational Planners." OECD Observer No. 39 (April 1969): 31-35.

Kibbee, J., et al. An Education and Training Simulation of the USAF Base Engineer Automated Management System . Los Angeles: Technical Communications Inc., October 1969.

Kibbee, J.M.; Craft, C.J.; and Nanus, B. Management Games: A New Technique for Executive Development . New York: Reinhold Publishing Corp., 1962.

Kibel, B.M. "Gaming Simulation of Urban Spatial Processes." Thesis, University of California, 1970.

Kidder, S.J. Emotional Arousal and Attitude Change During Simulation Games . Center for the Study of the Social Organization of Schools. Baltimore: Johns Hopkins University, August, 1971.

Kidder, S.J. Simulation Games: Practical References, Potential Use, Selected Bibliography . Centre for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, August 1971.

Kidder, S.J. and Nafziger, A.W., eds. Proceedings of the National Gaming Council's Eleventh Annual Symposium . Center for the Study of the Social Organization of Schools. Baltimore: Johns Hopkins University, November 1972.

Klietsch, R.G. An Introduction to Learning Games & Instructional Simulations . St. Paul: Instructional Simulation, 1969.

Klietsch, R.G.; Wiegman F.B.; and Powell, J.R. Directory of Educational Simulation, Learning Games and Didactic Units . St. Paul: Instructional Simulations, 1969.

Kurke, M.I. "Decision Determinants in Multiple Choice Games." Thesis, American University, 1963.

Lewin, A.Y. and Weber, W.L. "Management Game Teams in Education and Organization Research: An Experiment on Risk Taking." Academic Management Journal 12 (March 1969): 49-58.

Liebert, D.E.; Swenson, S.A.; and Liebert, R.M. "Risk Taken by the Opponent and Experience of Subject as Determinants of Imitation in a Competitive Situation." Perceptual and Motor Skills 32(3) (June 1971): 719-722.

Livermore, W.P. The American Kriegsspiel , rev. ed. Boston: W.B. Clarke Co., 1898.

Livingston, S.A. The Academic Games: A Summary of Research Results (1967-1972) . Centre for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, December 1972.

Livingston, S.A. Two Types of Learning in a Business Simulation . Centre for Social Organization of Schools Report No. 104. Baltimore: Johns Hopkins University, June 1971.

Loewenstein, L.K. Annotated Bibliography on Urban Games . Monticello, Ill.: Council of Planning Librarians, 1971.

Lopez, F.M. Evaluating Executive Decision Making, The In-Basket Technique New York: American Management Association, 1966.

Luce, R.D. and Raiffa, H. Game and Decisions: A Study of the Behavioral Models Project . Bureau of Applied Social Research. New York: Columbia University, 1957.

Lynch, W.H. "A Design Optimization for a Two Player Strategic Missile Game Incorporating Both Offensive and Defensive Missiles." Thesis, University of California, 1971.

M.F.T.F.O.: A Gaming Simulation Report on Phase I . Institute for Community Development. East Lansing, Mich.: Michigan State University, January 1966.

McClusky, M.R. Perspectives on Simulation and Miniaturization . Alexandria, Va.: Human Resources Research Organization, June 1972.

McDonald, J. "New Game of Business." Fortune 79 (May 15, 1969): 143.

McDonald, J. and Ricciardi, F. "Business Decision Game." Fortune 57 (March 1958): 140.

McFarlan, F.W.; McKennedy, J.L.; and Geiler, J.A. The Management Game: Simulated Decision Making . London: MacMillan, 1970.

McGehee, W. "Business Gaming. Where They Fit Into Training." Textile World 116 (January 1966): 68-71.

McGregor, E.B. and Baker, R.F. "Gremex- A Management Game for the New Public Administration." Public Administration Review 32 (January 1972): 24-32.

McGuinness, J.S. "Managerial Game for an Insurance Company." Operations Research 8 (March-April 1960): 196-209.

McKay, W. "Computer Directed Instructional Games." Audiovisual Instruction 14 (April 1969): 37-40.

McKenney, J.L. "Evaluation of a Business Game in an MBA Curriculum." Journal of Business 35 (July 1962): 278-286.

McKenney, J.L. "Simulation Gaming for Management Development." Division of Research. Boston: Harvard Business School, 1967.

McKenney, J.L. and Dill, W.R. "Influences of Learning in Simulation Games." American Behavioral Scientist 10(2) (October 1966): 28-32.

McManus, G.J. "New League for Business Games." Iron Age 185 (February 4, 1960): 49.

McNair, D.D. and West, A.P. Jr. Development and Testing of a High School Business Game. Final Report . Bureau of Research. Washington, D.C.: Office of Education (DHEW), August 1970.

McRaith, J.F. and Goeldner, C.R. "A Survey of Marketing Games." Journal of Marketing 26 (July 1962): 69-72.

Malcom, D.G. "Bibliography on the Use of Simulation in Management Analysis." Operations Research 8 (March-April 1960): 169-177.

"Management Games in Selection and Development." Proceeding of the Executive Study Conference held May 5 & 6 1964 . Princeton: Educational Testing Service, 1964.

"Management-Skill Game Leads to Better Product Planning." Product Engineering 38 (September 11, 1967): 175-7.

Massey, J.O. "An Approach to More Effective Training for Executive Careers." Thesis, University of Southern California, 1967.

Mauello, J. and Cribbin, J.J. "Whatever Happened to Management Simulation." Management Review 61 (May 1972): 12-18.

Maxwell, C.; Domenet, J.G.; and Joyce, C.R.B. "Instant Experience in Clinical Trials a Novel Aid to Teaching by Simulation." Journal of Clinical Pharmacology & New Drugs 11(5) (September-October 1971): 323-331.

May. F.B. Introduction to Games of Strategy . Boston: Allyn and Bacon, 1970.

Mayer, C.S. and Herringer, F.C. "When Management Plays Games." Credit and Financial Management 67 (June 1965): 16.

Meier, R.C.; Newell, W.T.; and Pazer, H.L. Simulation in Business and Economics . Englewood Cliffs: Prentice Hall Inc., 1969.

Mellor, P. and Tocher, K.D. "A Steel Works Production Game." Operational Research Quarterly 14 (June 1963): 131-135.

Michelini, R.L. "Effects of Prior Interaction, Contact Strategy and Expectation of Meeting on Game Behavior and Sentiment." Journal of Conflict Resolution 15 (March 1971): 97-103.

Miller, S.H. "A Study of Risk Taking in a Computer Simulation Marketing Game." Thesis, Purdue University, 1969.

Monroe, M.W. Urban Games: Four Case Studies in Urban Development. University Extension, Dept. P. Berkeley: University of California, 1972.

Moore, L.F. "Business Games vs. Cases as Tools of Learning. Results of Research at University of Colorado." Training and Development Journal 21(10) (October 1967): 13-23.

Moore, L.F. "A Comparison of Five Production Management Games and Cases for Selected Aspects of Learning." Thesis, University of Colorado, 1965.

Naylor, T.H. "Bibliography 19. Simulation and Gaming." Computing Reviews 10 (1969): 61-69.

Nizlek, M.C. "An Investigation of a Learning Game as a Media for Presentation of Certain Aspects of the Transportation Planning Process." Ph.D. Thesis, West Virginia University, 1972.

Norton, J.H. "Simulation for Planning and Control." Management Review 61 (February 1972): 18-27.

O'Brian, R.J. "Playing Your Own Business Game." The Manager (May 1965): 51-53

Osterhaus, L.B. "Teaching Methodology for Administration." Improving College and University Teaching 13 (Winter 1965): 21-24.

Overholt, J., ed. First War Gaming Symposium Proceedings. Washington Operations Research Council, November 30, 1961.

Papaloizos, A. and Stiefel, R. "Effectiveness Of Participative Teaching Methods." The Alberta Journal of Educational Research 17(3) (September 1971): 179-190.

Parry, S.B. "The Name of the Game Is Simulation." Training & Development Journal 25(2) (February 1971):28-32.

Perritt, F. "Motivation Learning Through Simulation." Data Processing Magazine 13 (Winter 1971): 59-61.

Peters, W., et al. "Gaining a Perspective on Simulation and Gaming." The National Association of Secondary School Principals Bulletin 57 (February 1973): 43-49.

"Pick a Problem; Build a Business Game." Sales Management 88 (April 20, 1962): 81-82.

Plattner, J.W. and Herron, L.W. Simulation: Its Use in Employee Selection and Training. Management Bulletin No. 20 . New York: American Management Association Personnel Division, 1962.

"Profit Plan Game." Sales Management 106 (January 15, 1971): 41-47.

Radell, N. "Concepts of Management Gaming." Systems and Process Journal 15 (March 1964): 24-29.

Raia, A.P. "A Study of the Educational Value of Management Games." The Journal of Business 39 (July 1966): 339-352.

Rapoport, A. "Prospects for Experimental Games." Journal of Conflict Resolution 12 (December 1968): 461-470.

Raser, J.R. Simulation and Society: An Exploration of Scientific Gaming . Boston: Allyn and Bacon, 1969.

Rausch, E. Collective Bargaining: A Didactic Game . Chicago: Science Research Associates, 1968.

Rausch, E. Economic Decision Games . Chicago: Science Research Associates, 1968.

Redfield, C.E. "Should Business Men Play Management Games." Office 53 (June 1961): 14.

Resnick, H.S. "Simulating the Corporate Structure. A Learning Game for Industrial Education." American Vocational Journal 45 (September 1970): 37-39.

Rhodes, A. "Play Man Play." Financial Post 64 (January 24, 1970): sup; 9-12.

Rigney, J.W. and Towne, D.M. Research in Computer-Aided Performance Training. Final Report . Department of Psychology. Los Angeles: University of Southern California, October 1972.

Riley, V. and Young, J. Bibliography on War Gaming . Baltimore: Johns Hopkins University, 1957.

Robertson, G.N.; Fernald, C.G.; and Myers, J.G. "Computers in Behavioral Science: Decision Making and Learning: A Simulated Marketing Manager." Behavioral Science 15(4) (July 1970): 370-379.

Robertson, J.G. "Decision Making in Two-Person Two-Choice Zero-Sum Games Under Different Incentive Conditions." Thesis, Pennsylvania State University, 1961.

Rogers, V.M. and Goodloe, A.H. "Simulation Games as Method." Educational Leaderships 30 (May 1973): 729-732.

Rogers, V.M. and Kysilka, M.L. "Simulation Games: What and Why." Instructor 79 (March 1970): 94-95.

Rohrer, J.R. "Selected Ability and Interest Dimensions as Predictors of Success of College Students in Business Management Decision Gaming." Thesis, Kent State University, 1967.

Roman, P.A. "Implementation of a Career Decision Game on a Time Shared Computer. An Exploration of Its Value in a Simulated Guidance Environment Information System for Vocational Decisions." Graduate School of Education. Cambridge, Mass.: Harvard University, November 1969.

Schellenberger, R.E. "A Computerized Multipurpose Management Game Applied to Retailing." Journal of Retailing 41 (Winter 1965/66): 10-20.

Schellenberger, R.E. "A Computerized Multipurpose Retail Management Game." Thesis, University of North Carolina at Chapel Hill, 1963.

Schellenberger, R.E. "Development of a Computerized Multipurpose Retail Management Game." Graduate School of Business Administration. Chapel Hill, N.C.: University of North Carolina, 1965.

Schild, E.O. and Boocock, S.S., eds. Simulation Games in Learning . Beverly Hills: Sage Publications Inc., 1968.

Schmid, H.G., Brother. "An Experiment on the Reliability and Validity of the Performance Measure, Profits, in Two Management Games." Thesis, University of Minnesota, 1969.

Schnuberger, K.C. "Gaming as an Instrument of Farm Management Education-A Development and Evaluation." Ann Arbor: University Microfilms, 1968.

Schuler, W.E. "A Network Model of the Systems Acquisition Process for Game Simulation." Ph.D. Thesis, Purdue University, 1972.

Seiler, R.F. Using Financial Data in Business Decisions: A Competitive Game with an Accounting Emphasis . Columbus, Ohio: Charles F. Merrill Books Inc., 1965.

"Selective Bibliography on Simulation Games as Learning Devices." American Behavioral Scientist 10 (3) (November 1966): 34-35.

Shaw, J.I. "Reward Size and Game Playing Behavior." Scandinavian Journal of Psychology 13 (2) (1972): 121-132.

Shephard, R.W. "Wargaming as a Technique in the Study of Operations Research Problems." Operational Research Quarterly 14 (June 1963): 119.

Shubik, M. "Bibliography on Simulation, Gaming, Artificial Intelligence and Allied Topics." Journal of the American Statistical Association 55 (December 1960): 736-751.

Shubik, M. "Gaming: Costs and Facilities." Management Science. Series A 14 (11) (July 1968): 629.

Shubik, M. "On the Scope of Gaming." Management Science 18, No. 5, Part 2, (January 1972): 20-36.

Shubik, M. "Simulation and Gaming: A Symposium." AMA Management Report No. 55 . New York: American Management Association, 1961.

Shubik, M. and Brewer, G.D. Questionaire- Models, Computer Machine Simulations, Games and Studies . Santa Monica: RAND Corp., July 1971.

Shubik, M. and Brewer, G.D. Reviews of Selected Books and Articles on Gaming and Simulations . Santa Monica: RAND Corp., June 1972.

Shultz, R.D. "Decision Making in a Wildland Fire Game." Thesis, University of California, 1964.

"Simulation and Gaming: A Symposium." AMA Management Report, No 55 . New York: American Management Association General Management Division, 1961.

"Simulation Games and Learning Behavior." American Behavioral Scientist 10 (November 1966): 1-36.

"Simulation: The Game Explosion." Social Education 33 (February 1969): 175.

Sisson, R.L. "Games (Use in Operations Research and Management Science)." Systems and Procedures Management 12 (May 1961): 32-36.

Smith, P.M. "Management Games, Toy or Trend?" Office Management and American Business 21 (September 1960): 15-18.

Smith, W.N.; Estey, F.E.; and Vines, E.F. Integrated Simulation: An Interactive General Business Simulation Designed for Flexible Application in Management Education. Cincinnati: South Western Publishing Co., 1968.

Spitze, H.T. "Games that Teach." Journal of Home Economics 64 (April 1972): 8-12.

Stadsklev, R. A Comparative Study of Simulation Gaming and Lecture Discussion Method. Educational Resources Information Center, January 1970.

Stadsklev, R. Games Analysis System: An Analytical Instrument to Help Evaluate Simulation Games. Seward, Nebr.: Concordia Teachers College, March 1970.

Stadsklev, R. A System for Analyzing Social Simulations and Educational Games (SAS) or Game Analysis System (GAS). Seward, Nebr.: Concordia Teachers College, 1969.

Stanley, J.D. "Management Games; Education or Entertainment." Personnel Journal 41 (January 1962): 15-17.

Starbuck, W.H. and Kobrow, E. "The Effects of Advisors on Business Game Teams." American Behavioral Scientist 10(3) (November 1966): 28-30.

Stasulat, J.J. "The Effects of Business Game Complexity and Computer Location on Student Learning, Occupational Interest, and Attitude." Thesis, Pennsylvania State University, 1970.

Steger, J.A. "Simple but Effective Business Game for Undergraduates." Journal of Business Education 43 (February 1968): 202-205.

Steinmetz, L.L. and Patten, R.J. "Enthusiasm, Interest and Learning the Results of Game Training." Training and Development Journal 21 (April 1967): 26-34

Steinwachs, B. A Selected List of Urban and Environmental Gaming/Simulations. Environmental Simulation Laboratory. Ann Arbor: Michigan University, 1970.

Stern, M.E. "Catalytic Power of Business-Decision Gaming in Teaching Management Science." Computers and Automation 11 (November 1962): 12-14.

Stoll, C.S. and Inbar, M., eds. "Social Simulation." American Behavioral Scientist 12 (July 1969): 1-47.

Streufert, S.; Kliger, S.C.; Castore, C.H.; and Drive, M.J. "Tactical and Negotiations Game for Analysis of Decision Integration Across Decision Areas." Psychological Reports 20(1) (February 1967): 155-157.

Sussna, E. and Weber, C.E. "Price Agreements: An Experiment with a Complex Business Game." Quarterly Review of Economics and Business 6 (Autumn 1966): 53-62.

Symonds, G.H. "A Study of Management Behavior by Use of Competitive Business Games." Management Science. Series A 11(1) (September 1964): 135.

Syracuse University. Management Development Current Information Sources No. 1 . New York: Syracuse University, November 1967.

Syracuse University. Management Development Current Information Sources No. 17 . New York: Syracuse University, March 1968.

Tait, R. "Business Games are More Than Fun." International Management 25 (October 1970): 35.

Tansey, P.J. and Unwin, D. Simulation and Gaming in Education . London: Methuen Educational Ltd., 1969.

Tansey, P.J. and Unwin, D. "Sources in Simulation and Academic Gaming: An Annotated Bibliography." British Journal of Educational Studies 17 (June 1969): 193-208.

Taylor, J.L. "Development and Application of a Terminal Air Battle Model." Operations Research 7 (November-December 1959): 783-796.

Taylor, J.L. Instructional Planning Systems a Gaming-Simulation Approach to Urban Problems . London: Cambridge University Press, 1971.

Taylor, R.N. "The Development and Evaluation of an Instrument to Examine Individual Differences in Managerial Decision Style." Thesis, University of Minnesota, 1970.

Taylor, T.C. "Computer in Sales Training: Stimulating Salesmen by Simulating Sales." Sales Management 108 (May 1, 1972): 63.

Temple, V.E. "Simstate: A Computer Simulation Game for State Governments." Thesis, Duke University, 1971.

Thiel, G.E. "Serious Games Were Playing Today." Supervisory Management 15 (June 1970): 38-41.

Thoeny, A.R. and Horton, F.B. III. Simulation Games in Social Science, Teaching and Research: An Interim Report . Colorado Springs: Air Force Academy, April 1970.

Thomann, J. "When New is Really Old: A Look at Simulations and Games." Journal of Educational Data Processing 9(6) (1972): 13-16.

Thomas, C.J. and Deemer, W.L., Jr. "The Role of Operational Gaming in Operation Research." Operation Research 5(1) (February 1957): 1-27.

Thomas, D.B. Two Applications of Simulation in the Educational Environment . CAI Center Technical Memorandum No 31. Tallahassee, Fla.: Florida State University, February 1971.

Thompson, D.L. " Next Sales Meeting Try a Game." Journal of Marketing 27 (January 1963): 71-74.

Thorelli, H.B. "Integrated Use of Simulations in Management Education." Personnel Journal 43(2) (February 1964): 67.

Thorelli, H.B. and Graves, R.L. International Operations Simulation with Comments on Design and Use of Management Games . New York: Free Press of Glencoe, 1964.

Thorelli, H.B., et al. "International Operations Simulation at the University of Chicago (INTOP)." Journal of Business 35 (July 1962): 287-297.

Thorelli, H.B.; Graves, R.L.; and Howells, L.T. Intop: International Operations Simulation Player's Manual . London: Collier - MacMillan, 1963.

Thornton, B. Gaming Technique for City Planning . Monticello, Ill.: Council of Planning Librarians, 1971.

Thorpe, G.L. "A Brief Summary of Research in Learning through the Use of Simulation Games." The High School Journal 54 (April 1971): 454-469.

Tiede, R.V. and Leake, L.A. " A Method for Evaluating the Combat Effectiveness of a Tactical Information System in a Field Army." Operations Research 19(3) (May-June 1971): 587-604.

Tippitt, F.W. and Forman, H.N. Jr. "Play Games to Cut Errors." Petroleum Management 36 (October 1964): 65-69.

Twelker, P.A. A Basic Reference Shelf on Simulation and Gaming. A Series One Paper from ERIC at Stanford . ERIC Clearing House on Educational Media and Technology, 1970.

Twelker, P.A. "Simulation: State of the Field." Paper Presented at the Conference, Simulation: Stimulation for Learning, Boston, Mass., October 1968.

Twelker, P.A. and Layden, K. Educational Simulation/Gaming . Stanford, Palo Alto, Calif.: Stanford University, August 1972.

Twelker, P.A., ed. Instructional Simulation Systems: An Annotated Bibliography . Corvallis, Oregon: Continuing Education Publications, 1969.

Twelker, P.A., et al., eds. Instructional Simulation: A Research Development and Dissemination Activity. Final Report . Teaching Research Division. Monmouth: Oregon State System of Higher Education, 1969.

Tyran, M.R. "Simulator Model Applications." Management Accounting 54 (October 1972): 13-18.

Umpleby, S. "Illinois Delphi Exploration of Alternative Futures." Journal of Aesthetic Education 4 (January 1970): 129-132.

Vance, S. Management Decision Simulation: A Non-Computer Business Game . New York: McGraw Hill, 1960.

Vance, S.C. and Gray, C.F. "Use of a Performance Evaluation Model for Research in Business Gaming." Academic Management Journal 10 (March 1967): 27-37.

Vinacke, W.E. "Variables in Experimental Games: Toward a Field Theory." Psychological Bulletin 71(4) (April 1969): 293-318.

Wagner, A.R. "The Use of Process Analysis in Business Decision Games." Journal of Applied Behavioral Science 1(4) (1965): 387-408.

Watkins, H.R. "Business Games in Business." Operations Research Quarterly 10 (December 1959): 228-244.

Webb, P.C. and Wheeler, G.E. "Operation Taurus: A Business Game Designed for the Building Industry." Journal of Industrial Economics 10 (March 1962): 118.

Weiner, M.G. War Gaming Methodology . Santa Monica: RAND Corp., July 10, 1959.

Whaley, D. "Simulate Industry in a Laboratory Factory." Industrial Arts & Vocational Education 59 (October 1970): 39-42.

Whitman, D. and Lave, R., Jr. "How Games Can Boost Industrial Engineering Education." Industrial Engineering 1 (March 1969): 67-73.

Wichman, H.A. "Effects of Isolation and Communication on Cooperation in a Two Person Game." Ph.D. Thesis, Claremont Graduate School and University Center, 1970.

Wigderson, H.I. The Name of the Game Simulation Research Brief No 4 . Visalia, Calif.: ADAPT A PACE Supplementary Educational Center, June 1968.

Wikstrom, W.S. "Serious Business of Business Games." Management Record 22 (February 1960): 6-8.

"Will This Quiz Stump Your Middle Managers." Business Management 24 (August 1963): 40-43.

Willcox, B.A.M. and Mark, D. "The Computer Game." Times (London) Educational Supplement 2608 (May 14, 1965): 1480.

Williams, E.H. "Business Games: Their Use for the Training of Managers." Personnel Management 43 (December 1961): 239-244.

Williams, J.D. The Compleat Strategyst . New York: McGraw Hill, 1966.

Wolpert, J. "Regional Simulation of Information Diffusion." Public Opinion Quarterly 30 (Winter 1966-67): 597-608.

Yelon, S.L. and Schmidt, W.H. "Effect of Objectives and Instructions on the Learning of a Complex Cognitive Task." Journal of Experimental Education 41 (Spring 1973): 91-96.

Young, J.P. A Survey of Historical Developments in War Games . Operations Research Office Staff Paper 98 (Now Research Analysis Corporation), August 1959.

Zoll, A.A. Dynamic Management Education, An Introduction to the Selection, Creation and Use of Cases, In-Basket Exercises, The Action Maze, Business Games and Other Dynamic Teaching Devices . Seattle: Management Education Associates, 1966.

Zuckerman, D.W. and Horn, R.E. The Guide to Simulation Games for Education and Training . Cambridge, Mass.: Information Resources Inc., 1970.

Zuckerman, D.W. and Horn, R.E. The Guide to Simulation Games for Education and Training . 2nd ed. Lexington, Mass.: Information Resources Inc., 1973.

A SELECTED BIBLIOGRAPHY

ON

GAMING AND SIMULATION

ORGANIZED BY SUBJECT

A. GAMES AS A TECHNIQUE

1. GAMES AS A TOOL FOR RESEARCH

Babb, E.M., et al. "Potential of Business Gaming Methods In Research." Journal of Business 39 (October 1966): 465-472.

Bass, B.M. "Business Gaming for Organizational Research." Management Science 10(3) (April 1964): 545.

Bloomfield, L.P. and Padelford, N.J. "Three Experiments in Political Gaming." American Political Science Review 53 (December 1959): 1105-1115.

Braasch, J.M. "Business Games Programmed Players, and Individual Decision Making Profiles." Thesis, University of Minnesota, 1966.

Clark, D.E. and Ackoff, R.L. "Report On Some Organizational Experiments." Operations Research 7 (May 1959): 279-293.

Cohen, K.J. and Rhenman, E. "The Role of Management Games in Education and Research." Managment Science 7(2) (January 1961): 131.

Day, R.P. and Lymberopoulas, P.J. "Decision Game: Progress and Prospects." Southwestern Social Science Quarterly 42 (December 1961): 250-258.

Ellis, N.D. "The Relationship Between Identifiable Attributes and Decision-Making Ability of Purchasing Personnel as Measured by the Results of a Management Game." Thesis, North Texas State University, 1973.

Hart, J.T. "Gaming as a Research Tool in International Relations." Thesis, American University, 1967.

Sisson, R.L. "Games (Use in Operations Research and Management Science)." Systems and Procedures Management 12 (May 1961): 32-36.

Streufert, S.; Kliger, S.C.; Castore, C.H.; and Drive, M.J. "Tactical and Negotiations Game for Analysis of Decision Integration Across Decision Areas." Psychological Reports 20(1) (February 1967): 155-157.

Taylor, J.L. Instructional Planning Systems a Gaming-Simulation Approach to Urban Problems . London: Cambridge University Press, 1971.

Taylor, R.N. "The Development and Evaluation of an Instrument to Examine Individual Differences in Managerial Decision Style." Thesis, University of Minnesota, 1970.

Thomann, J. "When New is Really Old: A Look at Simulations and Games." Journal of Educational Data Processing 9(6) (1972): 13-16.

Vance, S.C. and Gray, C.F. "Use of a Performance Evaluation Model for Research in Business Gaming." Academic Management Journal 10 (March 1967): 27-37.

2. GAMES AS A TOOL FOR EDUCATION

Amos, J.M. "Educational Aspects of Business Games." Journal of Business Education 40 (November 1964): 61-62.

Anderson, C.P. "The Effectiveness of a Simulation Learning Game in Teaching Consumer Credit To Senior High School Students in Comparison to a Conventional Approach to Instruction." Thesis, University of Maryland, 1969.

Ashmun, F.D. "The Effectiveness of a Non-Computer Business Game in Teaching Post-High School Business Problem Classes." Thesis, University of Minnesota, 1966.

Attig, J.C. "Use of Games as a Teaching Technique." The Social Studies 58 (January 1967): 25-29.

Beals, P.E. "Games and Simulation." Grade Teacher 88 (March 1971): 94.

"Business Games at High Speed." Industrial Canada 62 (August 1961): 28-30.

Calvert, D.E. "Pros and Cons of Management Games." Educational Technology 12 (June 1972): 62-4.

Cherryholmes, C.H. "Some Current Research on Effectiveness of Educational Simulations: Implications for Alternative Strategies." American Behavioral Scientist 10(2) (October 1966): 4-7.

Cohen, K.J. and Rhenman, E. "The Role of Management Games in Education and Research." Managment Science 7(2) (January 1961): 131.

Coleman, J.S. "Learning Through Games: Opinions Differ." NEA Journal 56 (January 1967): 69-70.

Coleman, J.S. The Role of Modern Technology in Relation to Simulation and Games For Learning . Washington: Academy for Educational Development Inc., 1970.

Crawford, M.P. "Simulation in Training and Education." Human Resources Research Office Professional Paper, 1967.

Culbertson, J., et al. The Design and Development of Prototype Instructional Materials for Preparing Educational Administrators. Final Report . University Council for Educational Administration, 1968.

Day, R.P. and Lymberopoulas, P.J. "Decision Game: Progress and Prospects." Southwestern Social Science Quarterly 42 (December 1961): 250-258.

Dill, W.R. and Doppett, N. "The Acquisition of Experience in a Complex Management Game." Management Science 10(1) (October 1963): 30-46.

Drumheller, S.J. "Curriculum Making as a Game Designing Task." Educational Technology 12(5) (May 1972): 13-17.

Duff, T.B. "Simulation Games; A Basic Business Natural." Business Education Forum 26 (March 1972): 65-66.

Dyck, J.J.J. van. "Understanding of the Organization Process Via the Management Game." Journal of Management Studies 5(3) (October 1968): 338.

Fennessey, G.M., et al. Simulation, Gaming and Conventional Instruction: An Experimental Comparison . Center for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, 1972.

Greenlaw, P.S.; Herron, L.W.; and Rawdon, R.H. Business Simulation in Industrial and University Education . Englewood Cliffs: Prentice Hall Inc., 1962.

Griffen, C.H. and Williams, T.H. "Simulation in Business Education." Accounting Review 39(1) (January 1964): 160.

Harpstrite, J.J. "An Analysis of Selected Simulation Games and the Assessment of the Subjective Feelings of Students and Teachers Who Use Simulation Games in Social Studies Instruction." Thesis, Michigan State University, 1971.

Haseley, A.F. "Information and Decision Making in a Management Game." Thesis, Purdue University, 1966.

Jensen, B.T. "Business Games for Executive Training." Advanced Management-Office Executive 2 (June 1963): 13-18.

Johnson, R.R. DATACALL: A Computer Based Simulation Game for Teaching Research Strategy . Department of Psychology. Richmond, Ind.: Earlham College, September 1971.

Kasperson, R.E. "Games as Educational Media." Journal of Geography 67 (October 1968): 409-422.

Khan, A. and Levasseur, P. "Use of Gaming as a Technique for Training Educational Planners." OECD Observer No. 39 (April 1969): 31-35.

Klietsch, R.G. An Introduction to Learning Games & Instructional Simulations . St. Paul: Instructional Simulation, 1969.

McClusky, M.R. Perspectives on Simulation and Miniaturization . Alexandria, Va.: Human Resources Research Organization, June 1972.

Moore, L.F. "Business Games vs. Cases as Tools of Learning. Results of Research at University of Colorado." Training and Development Journal 21(10) (October 1967): 13-23.

Moore, L.F. "A Comparison of Five Production Management Games and Cases for Selected Aspects of Learning." Thesis, University of Colorado, 1965.

Nizlek, M.C. "An Investigation of a Learning Game as a Media for Presentation of Certain Aspects of the Transportation Planning Process." Ph.D. Thesis, West Virginia University, 1972.

Osterhaus, L.B. "Teaching Methodology for Administration." Improving College and University Teaching 13 (Winter 1965): 21-24.

Papaloizos, A. and Stiefel, R. "Effectiveness Of Participative Teaching Methods." The Alberta Journal of Educational Research 17(3) (September 1971): 179-190.

Raia, A.P. "A Study of the Educational Value of Management Games." The Journal of Business 39 (July 1966): 339-352.

Resnick, H.S. "Simulating the Corporate Structure. A Learning Game for Industrial Education." American Vocational Journal 45 (September 1970): 37-39.

Rigney, J.W. and Towne, D.M. Research in Computer-Aided Performance Training. Final Report . Department of Psychology. Los Angeles: University of Southern California, October 1972.

Rigney, J.W. and Towne, D.M. Research in Computer-Aided Performance Training. Final Report . Department of Psychology. Los Angeles: University of Southern California, October 1972.

Rogers, V.M. and Kysilka, M.L. "Simulation Games: What and Why." Instructor 79 (March 1970): 94-95.

Stadsklev, R. A Comparative Study of Simulation Gaming and Lecture Discussion Method . Educational Resources Information Center, January 1970.

Steinmetz, L.L. and Patten, R.J. "Enthusiasm, Interest and Learning the Results of Game Training." Training and Development Journal 21 (April 1967): 26-34

Thorelli, H.B. "Integrated Use of Simulations in Management Education." Personnel Journal 43(2) (February 1964): 67.

Wigderson, H.I. The Name of the Game Simulation Research Brief No 4 . Visalia, Calif.: ADAPT A PACE Supplementary Educational Center, June 1968.

Zoll, A.A. Dynamic Management Education, An Introduction to the Selection, Creation and Use of Cases, In-Basket Exercises, The Action Maze, Business Games and Other Dynamic Teaching Devices . Seattle: Management Education Associates, 1966.

3. GENERAL

Abt, C.C. "Games and Simulation." Paper presented to Abington Conference on New Directions in Individualizing Instruction, April 1967.

Abt, C.C. Serious Games . New York: Viking Press, 1970.

Acer, J.W. Business Games: A Simulation Technique . Bureau of Labor and Management. University of Iowa, 1960.

Avedon, E.M. and Sutton-Smith, B. The Study of Games . New York: J. Wiley, 1971.

Banks, M.H.; Groom, A.J.R.; and Oppenheim, A.N. "Gaming and Simulation in International Relations." Political Studies 16 (February 1968): 1-17.

Barton, R.F. A Primer On Simulation and Gaming . Englewood Cliffs: Prentice Hall Inc., 1970.

Boardman, R. "Theory and Practice of Educational Simulation." Educational Research 11(3) (June 1969): 179-184.

Boocock, S.S. "The Effects of Games With Simulated Environments Upon Student Learning." Thesis, Johns Hopkins University, 1966.

Boocock, S.S. and Coleman, J.S. "Games With Simulated Environments in Learning." Sociology of Education 39 (Summer 1966):215-236.

Brammer, N.D. "A Comparative Investigation of the Use of Digital Computer System Simulation in Business Organizations." Thesis, University of Iowa, 1971.

Broom, H.N. Business Policy and Strategic Action . Englewood Cliffs: Prentice Hall Inc., 1969.

Burch, J.G., Jr. "Business Games and Simulations Techniques." Management Accounting 51 (December 1969): 49-52.

"Business Games For Fun and Profit." Industry Week 167 (July 6,1970):28-33.

Caldwell, J.C. "An Inquiry into Business Gaming as a Pedagogidal Technique in Accounting Education." Thesis, University of Alabama, 1970.

Carson, J.R. "Business Games: A Technique for Teaching Decision-Making." Management Accounting 49 (October 1967): 31-35.

Chapin, J.R. "Simulation Games." Social Education 32 (December 1968): 798-791.

Coghill, M.A. Games and Simulations in Industrial and Labor Relations Training . New York: State University of New York, and Ithaca: Cornell University, September 1971.

Cohen, K.J., et al. "Carnegie Tech Management Game." Journal of Business 33 (October 1960): 303-321.

Coiner, L.M. "Management Games: Win By Learning." Administrative Management 33, (March 1972): 16.

Coleman, J.S. "Academic Games and Learning." National Association of Secondary School Principals Bulletins 52 (February 1968): 62-72.

Collett, M.J. "Simulation as a Management Development Tool." Personnel Administration 25 (March 1962): 48-51.

"Computers and Management Games." Personnel Journal 40 (July-August 1961): 123.

Craft, C.J. and Kibbee, J.M. "Management Games." Canadian Chartered Accountant 79 (August 1961): 135-142.

Crawford, M.P. "Dimensions of Simulations." American Psychologist 21(8) (1966): 788-796.

Cruickshank, D.R. "The Notions of Simulations and Games: A Preliminary Inquiry." Educational Technology 12(7) (July 1972): 17-19.

Davis, K.R. "Systems Implementation: A Gaming Approach." Thesis, North Texas State University, 1972.

Day, R.P. and Lymberopoulas, P.J. "Decision Game: Progress and Prospects." Southwestern Social Science Quarterly 42 (December 1961): 250-258.

Deacon, A.R.L., Jr. Simulation and Gaming: A Symposium . New York: American Management Association General Management Division, 1961.

Decaroli, J. "Simulation Games." Social Education 36 (May 1972): 541-543.

Demak, L.S. and Devorkin, L. Games and Simulations: An Approach to Meaning Through Participation. Ideas in Motion . Detroit: Wayne County Intermediate School District, 1969.

Denhaam, A.E. "Dynamic Business Models a Tool to Meet New Business Challenges." Management Accounting 49 (May 1968): 3-11.

Dill, W.R.; Jackson, J.R.; and Sweeney, J.W., eds. Proceedings of the Conference on Simulation Games . New Orleans: Tulane University, 1961.

Dolbear, F.T., Jr., et al." Simulation Policy Game For Teaching Macroeconomics." American Economic Review: Papers and Proceedings 58 (May 1968): 458-468; 483-491.

Doney, L.D. "Management Simulations: The Next Step in Business Schools." Journal of Educational Data Processing 7, No. 6, (1970): 23-28.

Doob, P.A. Prospects for Simulation Gaming in Health Planning and Consumer Health Education . Department of Health Administration, School of Hygiene and Public Health. Baltimore: Johns Hopkins University, 1972.

Eilon, S. "Management Games." Operational Research Quarterly 14(2) (June 1963): 137-149.

"Games Men Play." Monetary Times 135 (September 1967): 31-33.

Gearon, J.D. "War or Peace: A Simulation Game." Social Education 30 (November 1966): 521-522: 31 (May 1967): 383-387.

Geisler, M.A. and Steger, W.A. "How To Plan For Management In New Systems." Harvard Business Review 40 (September 1962): 103-110.

Giffin, S.F. The Crisis Game: Simulating International Conflict . Garden City, N.Y.: Doubleday, 1965.

Goldhamer, H. and Speier, H. "Some Observations on Political Gaming." World Politics 12 (October 1959): 71-83.

Graham, R.G. and Gray, C.F. Business Games Handbook . New York: American Management Association, 1969.

Greene, J.R. and Sisson R.L. Dynamic Management Decision Games . New York: J. Wiley, 1959.

Haack, H.O. and Peterson, G.L. "Games for Simulating Urban Development Process." American Society of Civil Engineers Proceedings 97(UP2) (December 1971): 149-163.

Hausrath, A.H. Venture Simulation in War, Business and Politics . New York: McGraw Hill , 1971.

Helmer, O. Multipurpose Planning Games . Middletown, Conn.: Institute for the Future, Riverview Center, December 1971.

Hoggat , A.C., ed. "1973 Winter Simulations Conference." Proceeding of the Annual Winter Simulation Conference, Sixth . January 17-19, 1973.

Horn, R.E. and Zuckerman, D.W. "Getting into Simulation Games." Media & Methods 9 (November 1972): 65.

Hutte, H. "Decision-Taking in a Management Game." Human Relations 18 (February 1965): 5-20.

"In Business Education the Games the Thing." Business Week (July 25, 1959): 56-58.

Kelly, W.H. "Are Educational Games Effective in Teaching?" Agriculture Education Magazine 43 (November 1970): 117.

Kibbee, J.M.; Craft, C.J.; and Nanus, B. Management Games: A New Technique for Executive Development . New York: Reinhold Publishing Corp., 1962.

Kidder, S.J. Simulation Games: Practical References, Potential Use, Selected Bibliography . Centre for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, August 1971.

Kidder, S.J. and Nafziger, A.W., eds. Proceedings of the National Gaming Council's Eleventh Annual Symposium . Center for the Study of the Social Organization of Schools. Baltimore: Johns Hopkins University, November 1972.

Lewin, A.Y. and Weber, W.L. "Management Game Teams in Education and Organization Research: An Experiment on Risk Taking." Academic Management Journal 12 (March 1969): 49-58.

Livermore, W.R. The American Kriegsspiel , rev. ed. Boston: W.B. Clarke Co., 1898.

Livingston, S.A. The Academic Games: A Summary of Research Results (1967-1972) . Centre for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, December 1972.

Luce, R.D. and Raiffa, H. Game and Decisions: A Study of the Behavioral Models Project . Bureau of Applied Social Research. New York: Columbia University, 1957.

McDonald, J. "New Game of Business." Fortune 79 (May 15, 1969): 143.

McFarlan, F.W.; McKennedy, J.L.; and Geiler, J.A. The Management Game: Simulated Decision Making . London: MacMillan, 1970.

McGehee, W. "Business Gaming. Where They Fit Into Training." Textile World 116 (January 1966): 68-71.

McKenney, J.L. "Evaluation of a Business Game in an MBA Curriculum." Journal of Business 35 (July 1962): 278-286.

McKenney, J.L. "Simulation Gaming for Management Development." Division of Research. Boston: Harvard Business School, 1967.

"Management Games in Selection and Development." Proceeding of the Executive Study Conference held May 5 & 6 1964 . Princeton: Educational Testing Service, 1964.

Massey, J.O. "An Approach to More Effective Training for Executive Careers." Thesis, University of Southern California, 1967.

Mauello, J. and Cribbin, J.J. "Whatever Happened to Management Simulation." Management Review 61 (May 1972): 12-18.

May. F.B. Introduction to Games of Strategy . Boston: Allyn and Bacon, 1970.

Mayer, C.S. and Herringer, F.C. "When Management Plays Games." Credit and Financial Management 67 (June 1965): 16.

Meier, R.C.; Newell, W.T.; and Pazer, H.L. Simulation in Business and Economics . Englewood Cliffs: Prentice Hall Inc., 1969.

Norton, J.H. "Simulation for Planning and Control." Management Review 61 (February 1972): 18-27.

O'Brian, R.J. "Playing Your Own Business Game." The Manager (May 1965): 51-53

Overholt, J., ed. First War Gaming Symposium Proceedings . Washington Operations Research Council, November 30, 1961.

Parry, S.B. "The Name of the Game Is Simulation." Training & Development Journal 25(2) (February 1971):28-32.

Perritt, R. "Motivation Learning Through Simulation." Data Processing Magazine 13 (Winter 1971): 59-61.

Plattner, J.W. and Herron, L.W. Simulation: Its Use in Employee Selection and Training. Management Bulletin No. 20 . New York: American Management Association Personnel Division, 1962.

Radell, N. "Concepts of Management Gaming." Systems and Process Journal 15 (March 1964): 24-29.

Rapoport, A. "Prospects for Experimental Games." Journal of Conflict Resolution 12 (December 1968): 461-470.

Raser, J.R. Simulation and Society: An Exploration of Scientific Gaming . Boston: Allyn and Bacon, 1969.

Redfield, C.E. "Should Business Men Play Management Games." Office 53 (June 1961): 14.

Rhodes, A. "Play Man Play." Financial Post 64 (January 24, 1970): sup; 9-12.

Rogers, V.M. and Goodloe, A.H. "Simulation Games as Method." Educational Leaderships 30 (May 1973): 729-732.

Roman, R.A. "Implementation of a Career Decision Game on a Time Shared Computer. An Exploration of Its Value in a Simulated Guidance Environment Information System for Vocational Decisions." Graduate School of Education. Cambridge, Mass.: Harvard University, November 1969.

Schellenberger, R.E. "A Computerized Multipurpose Management Game Applied to Retailing." Journal of Retailing 41 (Winter 1965/66): 10-20.

Schellenberger, R.E. "A Computerized Multipurpose Retail Management Game." Thesis, University of North Carolina at Chapel Hill, 1963.

Schellenberger, R.E. "Development of a Computerized Multipurpose Retail Management Game." Graduate School of Business Administration. Chapel Hill, N.C.: University of North Carolina, 1965.

Schild, E.O. and Boocock, S.S., eds. Simulation Games in Learning . Beverly Hills: Sage Publications Inc., 1968.

Shephard, R.W. "Wargaming as a Technique in the Study of Operations Research Problems." Operational Research Quarterly 14 (June 1963): 119.

Shubik, M. "Gaming: Costs and Facilities." Management Science. Series A 14(11) (July 1968): 629.

Shubik, M. "On the Scope of Gaming." Management Science 18, No. 5, Part 2, (January 1972): 20-36.

Shubik, M. "Simulation and Gaming: A Symposium." AMA Management Report No. 55 . New York: American Management Association, 1961.

"Simulation and Gaming: A Symposium." AMA Management Report, No 55 . New York: American Management Association General Management Division, 1961.

"Simulation: The Game Explosion." Social Education 33 (February 1969): 175.

Smith, R.M. "Management Games, Toy or Trend?" Office Management and American Business 21 (September 1960): 15-18.

Stanley, J.D. "Management Games; Education or Entertainment." Personnel Journal 41 (January 1962): 15-17.

Steger, J.A. "Simple but Effective Business Game for Undergraduates." Journal of Business Education 43 (February 1968): 202-205.

Stern, M.E. "Catalytic Power of Business-Decision Gaming in Teaching Management Science." Computers and Automation 11 (November 1962): 12-14.

Stoll, C.S. and Inbar, M., eds. "Social Simulation." American Behavioral Scientist 12 (July 1969): 1-47.

Sussna, E. and Weber, C.E. "Price Agreements: An Experiment with a Complex Business Game." Quarterly Review of Economics and Business 6 (Autumn 1966): 53-62.

Symonds, G.H. "A Study of Management Behavior by Use of Competitive Business Games." Management Science. Series A 11(1) (September 1964): 135.

Tait, R. "Business Games are More Than Fun." International Management 25 (October 1970): 35.

Tansey, P.J. and Unwin, D. Simulation and Gaming in Education. London: Methuen Educational Ltd., 1969.

Thiel, G.E. "Serious Games Were Playing Today." Supervisory Management 15 (June 1970): 38-41.

Thoeny, A.R. and Horton, F.B. III. Simulation Games in Social Science, Teaching and Research: An Interim Report. Colorado Springs: Air Force Academy, April 1970.

Thomas, D.B. Two Applications of Simulation in the Educational Environment. CAI Center Technical Memorandum No 31. Tallahassee, Fla.: Florida State University, February 1971.

Thorpe, G.L. "A Brief Summary of Research in Learning through the Use of Simulation Games." The High School Journal 54 (April 1971): 454-469.

Tippitt, F.W. and Forman, H.N. Jr. "Play Games to Cut Errors." Petroleum Management 36 (October 1964): 65-69.

Twelker, P.A. "Simulation: State of the Field." Paper Presented at the Conference, Simulation: Stimulation for Learning, Boston, Mass., October 1968.

Twelker, P.A. and Layden, K. Educational Simulation/Gaming. Stanford, Palo Alto, Calif.: Stanford University, August 1972.

Twelker, P.A., et al., eds. Instructional Simulation: A Research Development and Dissemination Activity. Final Report. Teaching Research Division. Monmouth: Oregon State System of Higher Education, 1969.

Tyran, M.R. "Simulator Model Applications." Management Accounting 54 (October 1972): 13-18.

Watkins, H.R. "Business Games in Business." Operations Research Quarterly 10 (December 1959): 223-244.

Webb, P.C. and Wheeler, G.E. "Operation Taurus: A Business Game Designed for the Building Industry." Journal of Industrial Economics 10 (March 1962): 118.

Whaley, D. "Simulate Industry in a Laboratory Factory." Industrial Arts & Vocational Education 59 (October 1970): 39-42.

Whitman, D. and Lave, R., Jr. "How Games Can Boost Industrial Engineering Education." Industrial Engineering 1 (March 1969): 67-73.

Wikstrom, W.S. "Serious Business of Business Games." Management Record 22 (February 1960): 6-8.

Williams, E.H. "Business Games: Their Use for the Training of Managers." Personnel Management 43 (December 1961): 239-244.

Williams, J.D. The Compleat Strategyst . New York: McGraw Hill, 1966.

Young, J.P. A Survey of Historical Developments in War Games . Operations Research Office Staff Paper 98 (Now Research Analysis Corporation), August 1959.

B. GAME DESIGN

Abt, C.C. "Games and Simulation." Paper presented to Abington Conference on New Directions in Individualizing Instruction, April 1967.

Abt, C.C. Serious Games . New York: Viking Press, 1970.

Armstrong, R.H.R. and Taylor, J.L., eds. Instructional Simulation Systems in Higher Education . England: Cambridge Institute of Education, 1970.

Barton, R.F. A Primer On Simulation and Gaming . Englewood Cliffs: Prentice Hall Inc., 1970.

Brophy, P., et al. A Library Management Game: A Report on a Research Project . University of Lancaster Library. Lancaster, England: University of Lancaster, 1972.

Carlson, J.G. and Misshauk, M.J. Introduction to Gaming: Management Decision Simulations . New York: J. Wiley, 1972.

Cherryholmes, C.H. "Some Current Research on Effectiveness of Educational Simulations: Implications for Alternative Strategies." American Behavioral Scientist 10(2) (October 1966): 4-7.

Coghill, M.A. Games and Simulations in Industrial and Labor Relations Training . New York: State University of New York, and Ithaca: Cornell University, September 1971.

Collins, J.E. and Paulsen, T.D. The Modeling of Human Intelligence as Demonstrated in the Game of DIPLOMAT . Springfield: National Technical Information Service, 1970.

Craig, R.L. and Bittel, L.R., eds. Training and Development Handbook . New York: McGraw-Hill Bock Co., 1967.

Culbertson, J., et al. The Design and Development of Prototype Instructional Materials for Preparing Educational Administrators. Final Report . University Council for Educational Administration, 1968.

Demak, L.S. and Devorkin, L. Games and Simulations: An Approach to Meaning Through Participation. Ideas in Motion . Detroit: Wayne County Intermediate School District, 1969.

Drabek, T.E. and Haas, J.E. "Realism in Laboratory Simulation Myth or Method." Social Forces 45 (March 1967): 337-346.

Dresher, M. Games of Strategy: Theory and Applications . Englewood Cliffs: Prentice Hall Inc, 1961.

Edwards, K.J. The Effect of Ability Achievement, and Number of Plays on Learning from a Simulation Game. Report No. 115 . Center for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, September 1971.

Eilon, S. "Management Games." Operational Research Quarterly 14(2) (June 1963): 137-149.

Elder, C.D. "Problems in the Structure and Use of Educational Simulation." Sociology of Education 46 (Summer 1973): 335-354.

Haseley, A.F. "Information and Decision Making in a Management Game." Thesis, Purdue University, 1966.

Inbar, M. "The Differential Impact of a Game Simulating a Community Disaster and Its Implications for Games with Simulated Environment." Thesis, Johns Hopkins University, 1966.

Isaacs, R. Differential Games: A Mathematical Theory with Applications to Warfare, and Pursuit, Control and Optimization . New York: J. Wiley, 1967.

Kelly, W.H. "Are Educational Games Effective in Teaching?" Agriculture Education Magazine 43 (November 1970): 117.

Keys, J.B. "An Investigation of the Type of Managerial Behavior Elicited by Business Games by the Use of the Critical Incident Method." Thesis, University of Oklahoma, 1970.

Lopez, F.M. Evaluating Executive Decision Making, The In-Basket Technique New York: American Management Association, 1966.

M.E.T.R.O.: A Gaming Simulation Report on Phase I . Institute for Community Development. East Lansing, Mich.: Michigan State University, January 1966.

McClusky, M.R. Perspectives on Simulation and Miniaturization . Alexandria, Va.: Human Resources Research Organization, June 1972.

McGuinness, J.S. "Managerial Game for an Insurance Company." Operations Research 8 (March-April 1960): 196-209.

McKenney, J.L. "Simulation Gaming for Management Development." Division of Research. Boston: Harvard Business School, 1967.

McKenney, J.L. and Dill, W.R. "Influences of Learning in Simulation Games." American Behavioral Scientist 10(2) (October 1966): 28-32.

Massey, J.O. "An Approach to More Effective Training for Executive Careers." Thesis, University of Southern California, 1967.

Meier, R.C.; Newell, W.T.; and Pazer, H.L. Simulation in Business and Economics . Englewood Cliffs: Prentice Hall Inc., 1969.

Norton, J.H. "Simulation for Planning and Control." Management Review 61 (February 1972): 18-27.

Peters, W., et al. "Gaining a Perspective on Simulation and Gaming." The National Association of Secondary School Principals Bulletin 57 (February 1973): 43-49.

"Pick a Problem; Build a Business Game." Sales Management 88 (April 20, 1962): 81-82.

Schellenberger, R.E. "Development of a Computerized Multipurpose Retail Management Game." Graduate School of Business Administration. Chapel Hill, N.C.: University of North Carolina, 1965.

Schmid, H.G., Brother. "An Experiment on the Reliability and Validity of the Performance Measure, Profits, in Two Management Games." Thesis, University of Minnesota, 1969.

Schuler, W.E. "A Network Model of the Systems Acquisition Process for Game Simulation." Ph.D. Thesis, Purdue University, 1972.

Shephard, R.W. "Wargaming as a Technique in the Study of Operations Research Problems." Operational Research Quarterly 14 (June 1963): 119.

Shubik, M. "Gaming: Costs and Facilities." Management Science. Series A 14(11) (July 1968): 629.

Shubik, M. and Brewer, G.D. Questionaire- Models, Computer Machine Simulations, Games and Studies . Santa Monica: RAND Corp., July 1971.

"Simulation: The Game Explosion." Social Education 33 (February 1969): 175.

Starbuck, W.H. and Kobrow, E. "The Effects of Advisors on Business Game Teams." American Behavioral Scientist 10(3) (November 1966): 28-30.

Stasulat, J.J. "The Effects of Business Game Complexity and Computer Location on Student Learning, Occupational Interest, and Attitude." Thesis, Pennsylvania State University, 1970.

Taylor, R.N. "The Development and Evaluation of an Instrument to Examine Individual Differences in Managerial Decision Style." Thesis, University of Minnesota, 1970.

Thomas, C.J. and Deemer, W.L., Jr. "The Role of Operational Gaming in Operation Research." Operation Research 5(1) (February 1957): 1-27.

Thorelli, H.B. and Graves, R.L. International Operations Simulation with Comments on Design and Use of Management Games . New York: Free Press of Glencoe, 1964.

Twelker, P.A. and Layden, K. Educational Simulation/Gaming . Stanford, Palo Alto, Calif.: Stanford University, August 1972.

Twelker, P.A., et al., eds. Instructional Simulation: A Research Development and Dissemination Activity. Final Report . Teaching Research Division. Monmouth: Oregon State System of Higher Education, 1969.

Vinacke, W.E. "Variables in Experimental Games: Toward a Field Theory." Psychological Bulletin 71(4) (April 1969): 293-318.

Wagner, A.R. "The Use of Process Analysis in Business Decision Games." Journal of Applied Behavioral Science 1(4) (1965): 387-408.

Weiner, M.G. War Gaming Methodology . Santa Monica: RAND Corp., July 10, 1959.

Wolpert, J. "Regional Simulation of Information Diffusion." Public Opinion Quarterly 30 (Winter 1966-67): 597-608.

C. GAME ANALYSIS SYSTEMS

Amos, J.M. "Educational Aspects of Business Games." Journal of Business Education 40 (November 1964): 61-62.

Armstrong, R.H.R. and Taylor, J.L., eds. Instructional Simulation Systems in Higher Education . England: Cambridge Institute of Education, 1970.

Boocock, S.S. and Coleman, J.S. "Games With Simulated Environments in Learning." Sociology of Education 39 (Summer 1966):215-236.

Burnett, J.D. "Component Curve Analysis of Student Performance on a Computer-Based Simulation Game." Alberta Journal of Educational Research 17(2) (June 1971): 117-128.

Elder, C.D. "Problems in the Structure and Use of Educational Simulation." Sociology of Education 46 (Summer 1973): 335-354.

Ellis, N.D. "The Relationship Between Identifiable Attributes and Decision-Making Ability of Purchasing Personnel as Measured by the Results of a Management Game." Thesis, North Texas State University, 1973.

Henderson, B.G. and Gainer, W.G. "Assessment of Selected Simulations and Games for the Social Studies." Social Education 35 (May 1971): 508.

Lopez, F.M. Evaluating Executive Decision Making, The In-Basket Technique New York: American Management Association, 1966.

Stadsklev, R. Games Analysis System: An Analytical Instrument to Help Evaluate Simulation Games . Seward, Nebr.: Concordia Teachers College, March 1970.

Stadsklev, R. A System for Analyzing Social Simulations and Educational Games (SAS) or Game Analysis System (GAS) . Seward, Nebr.: Concordia Teachers College, 1969.

Vance, S.C. and Gray, C.F. "Use of a Performance Evaluation Model for Research in Business Gaming." Academic Management Journal 10 (March 1967): 27-37.

D. BEHAVIORAL FACETS

1. EFFECTS OF GAMES ON THE PARTICIPANTS

Ashmun, R.D. "The Effectiveness of a Non-Computer Business Game in Teaching Post-High School Business Problem Classes." Thesis, University of Minnesota, 1966.

Barringer, R.E. and Whaley, B. "MIT Political Military Gaming Experience." Orbis 9 (Summer 1965): 437-458.

Boocock, S.S. "The Effects of Games With Simulated Environments Upon Student Learning." Thesis, Johns Hopkins University, 1966.

Boocock, S.S. "An Experimental Study of the Learning Effects of Two Games With Simulated Environments." American Behavioral Scientist 10(2) (October 1966): 8-17.

Christian, A.D. "A Study of the Effects of Educational Game Experience Upon the Attitudes of Job Corps Trainees." Thesis, University of Texas at Austin, 1971.

Clark, D.E. and Ackoff, R.L. "Report On Some Organizational Experiments." Operations Research 7 (May 1959): 279-293.

Dill, W.R. and Doppett, N. "The Acquisition of Experience in a Complex Management Game." Management Science 10(1) (October 1963): 30-46.

Edwards, K.J. The Effect of Ability Achievement, and Number of Plays on Learning from a Simulation Game. Report No. 115 . Center for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, September 1971.

Edwards, K.J. Student's Evaluations of a Business Simulation Game as a Learning Experience. Report No. 121 . Centre for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, December 1971.

Edwards, K.J., et al. Games and Teams: A Winning Combination. Report No. 135 . Center for the Study of the Social Organization of Schools. Baltimore: Johns Hopkins University, July 1972.

Engel, A. and Maes, W.R. "Teaching Personality Theory: A Games Approach." Counselor Education and Supervision 11(1) (September 1971): 24-28.

Harpstrite, J.J. "An Analysis of Selected Simulation Games and the Assessment of the Subjective Feelings of Students and Teachers Who Use Simulation Games in Social Studies Instruction." Thesis, Michigan State University, 1971.

Haseley, A.F. "Information and Decision Making in a Management Game." Thesis, Purdue University, 1966.

Heinkel, O.A. "Evaluation of Simulation as a Teaching Device." Journal of Experimental Education 38 (Spring 1970): 32-36.

Keys, J.B. "An Investigation of the Type of Managerial Behavior Elicited by Business Games by the Use of the Critical Incident Method." Thesis, University of Oklahoma, 1970.

Kidder, S.J. Emotional Arousal and Attitude Change During Simulation Games . Center for the Study of the Social Organization of Schools. Baltimore: Johns Hopkins University, August, 1971.

Kurke, M.I. "Decision Determinants in Multiple Choice Games." Thesis, American University, 1963.

Livingston, S.A. Two Types of Learning in a Business Simulation . Centre for Social Organization of Schools Report No. 104. Baltimore: Johns Hopkins University, June 1971.

McKenney, J.L. and Dill, W.R. "Influences of Learning in Simulation Games." American Behavioral Scientist 10(2) (October 1966): 28-32.

Robertson, J.G. "Decision Making in Two-Person Two-Choice Zero-Sum Games Under Different Incentive Conditions." Thesis, Pennsylvania State University, 1961.

Shaw, J.I. "Reward Size and Game Playing Behavior." Scandinavian Journal of Psychology 13(2) (1972): 121-132.

"Simulation: The Game Explosion." Social Education 33 (February 1969): 175.

Starbuck, W.H. and Kobrow, E. "The Effects of Advisors on Business Game Teams." American Behavioral Scientist 10(3) (November 1966): 28-30.

Stasulat, J.J. "The Effects of Business Game Complexity and Computer Location on Student Learning, Occupational Interest, and Attitude." Thesis, Pennsylvania State University, 1970.

Wichman, H.A. "Effects of Isolation and Communication on Cooperation in a Two Person Game." Ph.D. Thesis, Claremont Graduate School and University Center, 1970.

Yelon, S.L. and Schmidt, W.H. "Effect of Objectives and Instructions on the Learning of a Complex Cognitive Task." Journal of Experimental Education 41 (Spring 1973): 91-96.

2. EFFECTS OF PARTICIPANTS ON THE GAME

Alderfer, C.P. "Effect of Individual Group and Intergroup Relations on Attitudes Toward A Management Development Program." Journal of Applied Psychology 55(4) (August 1971): 302-311.

Conrath, D.W. "Experience As a Factor In Experimental Gaming Behavior." Journal of Conflict Resolution 14 (June 1970): 195-202.

Deep, S.D., et al. "Some Effects on Business Gaming of Previous T-Group Affiliation." Journal of Applied Psychology 51 (October 1967): 426-431.

Ewing, S. "Selected Effects of Creativity and Risk Taking on Business Game Behavior: An Experimental Investigation." Thesis, Texas Technological College, 1973.

Goodman, R.F. "The Inter-Community: An Experiment in Simulation-Gaming." Thesis, University of California, 1968.

Gray, C.F. "A Comparison of Performance and Selected Personality Traits of Participants in a Total Enterprise Business Game." Thesis, University of Oregon, 1966.

Hunt, J.G. "Leadership Style Effects at Two Managerial Levels in a Simulated Organization." Administrative Science Quarterly 16 (December 1971): 476-485.

Liebert, D.E.; Swenson, S.A.; and Liebert, R.M. "Risk Taken by the Opponent and Experience of Subject as Determinants of Imitation in a Competitive Situation." Perceptual and Motor Skills 32(3) (June 1971): 719-722.

Michelini, R.L. "Effects of Prior Interaction, Contact Strategy and Expectation of Meeting on Game Behavior and Sentiment." Journal of Conflict Resolution 15 (March 1971): 97-103.

Miller, S.H. "A Study of Risk Taking in a Computer Simulation Marketing Game." Thesis, Purdue University, 1969.

Rigney, J.W. and Towne, D.M. Research in Computer-Aided Performance Training. Final Report . Department of Psychology. Los Angeles: University of Southern California, October 1972.

Rohrer, J.R. "Selected Ability and Interest Dimensions as Predictors of Success of College Students in Business Management Decision Gaming." Thesis, Kent State University, 1967.

E. GAMES

1. FARM

Babb, E.M. and Eisgruber, L.M. Management Games for Teaching and Research . Chicago: Educational Methods Inc., 1966.

Schnuberger, K.C. "Gaming as an Instrument of Farm Management Education-A Development and Evaluation." Ann Arbor: University Microfilms, 1968.

2. GENERAL

Adair, C.H.; Agarwal, A.; Hansen, D.N.; and Rayner, G.T. Two Simulated Inquiry Environments A Social Simulation Game and a CAI-Based Information Retrieval System . CAI Center Technical Memorandum. Tallahassee: Florida State University, 1970.

Banks, M.H.; Groom, A.J.R.; and Oppenheim, A.N. "Gaming and Simulation in International Relations." Political Studies 16 (February 1968): 1-17.

Brophy, P., et al. A Library Management Game: A Report on a Research Project . University of Lancaster Library. Lancaster, England: University of Lancaster, 1972.

Collins, J.E. and Paulsen, T.D. The Modeling of Human Intelligence as Demonstrated in the Game of DIPLOMAT . Springfield: National Technical Information Service, 1970.

Dolbear, F.T., Jr., et al." Simulation Policy Game For Teaching Macroeconomics." American Economic Review: Papers and Proceedings 58 (May 1968): 458-468; 483-491.

Gearon, J.D. "War or Peace: A Simulation Game." Social Education 30 (November 1966): 521-522: 31 (May 1967): 383-387.

Goldhamer, H. and Speier, H. "Some Observations on Political Gaming." World Politics 12 (October 1959): 71-83.

Gray, J.,; Willingham, J.; and Johnston, K. "Business Game For Introductory Course In Accounting." Accounting Review 38 (April 1963): 336-346.

Henderson, B.G. and Gainer, W.G. "Assessment of Selected Simulations and Games for the Social Studies." Social Education 35 (May 1971): 508.

House, P.W., et al. National Gaming Council . Washington: Envirometrics Inc., April 17, 1970.

Iverson, R.W. MIDSIM: The Maxwell International Development Simulation . Continuing Center for the Public Service. Syracuse: Syracuse University, 1971.

Johnson, R.R. DATACALL: A Computer Based Simulation Game for Teaching Research Strategy . Department of Psychology. Richmond, Ind.: Earlham College, September 1971.

Kidder, S.J. and Nafziger, A.W., eds. Proceedings of the National Gaming Council's Eleventh Annual Symposium . Center for the Study of the Social Organization of Schools. Baltimore: Johns Hopkins University, November 1972.

McKay, W. "Computer Directed Instructional Games." Audiovisual Instruction 14 (April 1969): 37-40.

Nizlek, M.C. "An Investigation of a Learning Game as a Media for Presentation of Certain Aspects of the Transportation Planning Process." Ph.D. Thesis, West Virginia University, 1972.

Rausch, E. Economic Decision Games . Chicago: Science Research Associates, 1968.

Roman, R.A. "Implementation of a Career Decision Game on a Time Shared Computer. An Exploration of Its Value in a Simulated Guidance Environment Information System for Vocational Decisions." Graduate School of Education. Cambridge, Mass.: Harvard University, November 1969.

Shultz, R.D. "Decision Making in a Wildland Fire Game." Thesis, University of California, 1964.

Spitze, H.T. "Games that Teach." Journal of Home Economics 64 (April 1972): 8-12.

Steinwachs, B. A Selected List of Urban and Environmental Gaming/Simulations . Environmental Simulation Laboratory. Ann Arbor: Michigan University, 1970.

Streufert, S.; Kliger, S.C.; Castore, C.H.; and Drive, M.J. "Tactical and Negotiations Game for Analysis of Decision Integration Across Decision Areas." Psychological Reports 20(1) (February 1967): 155-157.

Temple, V.E. "Simstate: A Computer Simulation Game for State Governments." Thesis, Duke University, 1971.

Umpleby, S. "Illinois Delphi Exploration of Alternative Futures." Journal of Aesthetic Education 4 (January 1970): 129-132.

Whaley, D. "Simulate Industry in a Laboratory Factory." Industrial Arts & Vocational Education 59 (October 1970): 39-42.

Willcox, B.A.M. and Mark, D. "The Computer Game." Times (London) Educational Supplement 2608 (May 14, 1965): 1480.

3. GEOGRAPHICAL

Blouet, B.W. and Buckwalter, D. "Operational Games for Geographers: Economic Development Problems on an Imaginary Caribbean Island." Journal of Geography 70 (November 1971): 487-491.

Croft, J.D. "The Development and Evaluation of a Geographical Simulation Game Involving the Arkansas River Project." Thesis, University of Tulsa, 1971.

4. INDUSTRIAL AND LABOR RELATIONS

Gearon, J.D. "Labor vs. Management: A Simulation Game." Social Education 37 (October 1973): 514-515.

Rausch, E. Collective Bargaining: A Didactic Game . Chicago: Science Research Associates, 1968.

5. MANAGEMENT

Abt, C.C. An Education System Planning Game . Educational Resources Information Center, 1965.

Baker, R.F. "GREMEX: Goddard Research and Engineering Management Exercise." Educational Technology 10 (January 1970): 61-63.

Bass, B.M. "Business Gaming for Organizational Research." Management Science 10(3) (April 1964): 545.

Becht, J.E., et al. Mantrap: Management Training Program . Centre For Research in Business and Economics. Texas: University of Houston, 1963.

Brammer, N.D. "A Comparative Investigation of the Use of Digital Computer System Simulation in Business Organizations." Thesis, University of Iowa, 1971.

Broom, H.N. Business Policy and Strategic Action . Englewood Cliffs: Prentice Hall Inc., 1969.

Carlson, J.G. and Misshauk, M.J. Introduction to Gaming: Management Decision Simulations . New York: J. Wiley, 1972.

Cohen, K.J. and Rhenman, E. "The Role of Management Games in Education and Research." Managment Science 7(2) (January 1961): 131.

Cohen, K.J., et al. "Carnegie Tech Management Game." Journal of Business 33 (October 1960): 303-321.

Croy, D. "Computer Games [Solid]." Best's Review (Life/Health Insurance Edition) 70 (October 1969): 10-12.

Culbertson, J., et al. The Design and Development of Prototype Instructional Materials for Preparing Educational Administrators. Final Report . University Council for Educational Administration, 1968.

Dale, A.G. "Management Decision Tester: Computer Used to Simulate Operations of Small Business." Computers and Automation 11 (October 1962): 47-49.

Dennick, W.H. and Olanie, F.X., Jr. "Bank Management Game [Simulated Operation With Aid of IBM 650 Computer]." Bankers Monthly 77 (September 1970): 56-60.

Des Jardins, R.B. "An Investigation of Decision Systems in a Complex Management Game." Thesis, University of North Carolina at Chapel Hill, 1965.

Greenlaw, P.S. and Frey, M.W. FINANSIM: A Financial Management Simulation . Scranton: International Textbook Co. 1967.

Hawkes, R. "Computer Simulates Executives Problems (Lockheed's Aerospace Business Environment Simulator)." Aviation Week and Space Technology 76 (June 18, 1962): 87-91.

Helmer, O. and Bickner, R.E. How to Play SAFE: Book of Rules of the Strategy and Force Evaluation Game. Santa Monica: RAND Corporation, November 1961.

Herron, L.W. Executive Action Simulation . Englewood Cliffs: Prentice-Hall Inc., 1960.

Homan, K.V. and Burns, E.M. "Do Rather Than Drill in General Business." Journal of Business Education 44 (March-April 1969): 233-235, 288-291.

Kibbee, J., et al. An Education and Training Simulation of the USAF Base Engineer Automated Management System . Los Angeles: Technical Communications Inc., October 1969.

McDonald, J. and Ricciardi, F. "Business Decision Game." Fortune 57 (March 1958): 140.

McGregor, E.B. and Baker, R.F. "Gremex- A Management Game for the New Public Administration." Public Administration Review 32 (January 1972): 24-32.

McGuinness, J.S. "Managerial Game for an Insurance Company." Operations Research 8 (March-April 1960): 196-209.

McKenney, J.L. "Simulation Gaming for Management Development." Division of Research. Boston: Harvard Business School, 1967.

McManus, G.J. "New League for Business Games." Iron Age 185 (February 4, 1960): 49.

McNair, D.D. and West, A.P. Jr. Development and Testing of a High School Business Game. Final Report . Bureau of Research. Washington, D.C.: Office of Education (DHEW), August 1970.

O'Brian, R.J. "Playing Your Own Business Game." The Manager (May 1965): 51-53

"Profit Plan Game." Sales Management 106 (January 15, 1971): 41-47.

Schellenberger, R.E. "A Computerized Multipurpose Management Game Applied to Retailing." Journal of Retailing 41 (Winter 1965/66): 10-20.

Schellenberger, R.E. "A Computerized Multipurpose Retail Management Game." Thesis, University of North Carolina at Chapel Hill, 1963.

Schellenberger, R.E. "Development of a Computerized Multipurpose Retail Management Game." Graduate School of Business Administration. Chapel Hill, N.C.: University of North Carolina, 1965.

Seiler, R.F. Using Financial Data in Business Decisions: A Competitive Game with an Accounting Emphasis . Columbus, Ohio: Charles E. Merrill Books Inc., 1965.

Smith, W.N.; Estey, E.E.; and Vines, E.F. Integrated Simulation: An Interactive General Business Simulation Designed for Flexible Application in Management Education . Cincinnati: South Western Publishing Co., 1968.

Steger, J.A. "Simple but Effective Business Game for Undergraduates." Journal of Business Education 43 (February 1968): 202-205.

Symonds, G.H. "A Study of Management Behavior by Use of Competitive Business Games." Management Science. Series A 11(1) (September 1964): 135.

Taylor, T.C. "Computer in Sales Training: Stimulating Salesmen by Simulating Sales." Sales Management 108 (May 1, 1972): 63.

Thorelli, H.B. and Graves, R.L. International Operations Simulation with Comments on Design and Use of Management Games . New York: Free Press of Glencoe, 1964.

Thorelli, H.B., et al. "International Operations Simulation at the University of Chicago (INTOP)." Journal of Business 35 (July 1962): 287-297.

Thorelli, H.B.; Graves, R.L.; and Howells, L.T. Intop: International Operations Simulation Player's Manual . London: Collier - MacMillan, 1963.

Vance, S. Management Decision Simulation; A Non-Computer Business Game . New York: McGraw Hill, 1960.

Webb, P.C. and Wheeler, G.E. "Operation Taurus: A Business Game Designed for the Building Industry." Journal of Industrial Economics 10 (March 1962): 118.

Weiner, M.G. War Gaming Methodology . Santa Monica: RAND Corp., July 10, 1959.

"Will This Quiz Stump Your Middle Managers." Business Management 24 (August 1963): 40-43.

6. MARKETING

Bickham, L.B. "A Marketing Management Game Designed with Particular Emphasis on Channels of Distribution." Thesis, University of Texas, 1965.

Day, R.L. Marketing in Action; A Decision Game , rev. ed. Homewood, Ill.: R.D. Irwin, 1968.

Day, R.L. Marketing in Action: A Dynamic Business Decision Game . Homewood, Ill.: R.D. Irwin, 1962.

Greenlaw, P.S. and Kniffin, F.W. MARKSIM: A Marketing Decision Simulation . Scranton: International Textbook Co., 1964.

Henry, C. "Market Games with Indivisible Commodoties and Non-Convex Preferences." Review of Economic Studies 39 (January 1972): 73-76.

Honegger, G.D. "A Business Game Approach To Market Planning." Thesis, Purdue University, 1969.

Robertson, G.N.; Fernald, C.G.; and Myers, J.G. "Computers in Behavioral Science: Decision Making and Learning: A Simulated Marketing Manager." Behavioral Science 15(4) (July 1970): 370-379.

Thompson, D.L. " Next Sales Meeting Try a Game." Journal of Marketing 27 (January 1963): 71-74.

7. PRODUCTION

Anderson, D.W. "Game That Teaches Production Control Techniques (Managram)." Office 55 (May 1962): 132.

Greenlaw, P.S. and Hottenstein, M.P. PROSIM: A Production Management Game . Scranton: International Textbook Co., 1969.

"In Business Education the Games the Thing." Business Week (July 25, 1959): 56-58.

Mellor, P. and Tocher, K.D. "A Steel Works Production Game." Operational Research Quarterly 14 (June 1963): 131-135.

Resnick, H.S. "Simulating the Corporate Structure. A Learning Game for Industrial Education." American Vocational Journal 45 (September 1970): 37-39.

8. R&D

Dillman, D.H. and Cook, D.L. Simulation in the Training of R&D Project Managers . Educational Program Management Center. Columbus: The Ohio State University, 1969.

"Management-Skill Game Leads to Better Product Planning." Product Engineering 38 (September 11, 1967): 175-7.

Maxwell, C.; Domenet, J.G.; and Joyce, C.R.B. "Instant Experience in Clinical Trials a Novel Aid to Teaching by Simulation." Journal of Clinical Pharmacology & New Drugs 11(5) (September-October 1971): 323-331.

9. URBAN PLANNING AND LAND USE

Duke, R.D. Gaming Simulation in Urban Research . The Institute for Community Development and Services. East Lansing, Mich.: Continuing Education Services, Michigan State University, 1964.

Feldt, A.G., et al. CLUG: Community Land Use Games: Players Manual with Selected Readings . New York: Free Press, 1972.

House, P. Development of Metropolitan (City III) Model. Final Report . Washington: Environmetrics Inc., 1970.

Kibel, B.M. "Gaming Simulation of Urban Spatial Processes." Thesis, University of California, 1970.

M.F.T.R.O.: A Gaming Simulation Report on Phase I . Institute for Community Development. East Lansing, Mich.: Michigan State University, January 1966.

Monroe, M.W. Urban Games: Four Case Studies in Urban Development . University Extension, Dept. P. Berkeley: University of California, 1972.

10. WAR

Adams, R.H. and Jenkins, J.L. "Simulation of Air Operations with the Air-Battle Model." Operations Research 8 (September-October 1960): 600-615.

Brotman, L. and Seid, B. "Digital Simulations of a Massed-Bomber, Manned-Interceptor Encounter." Operations Research 8 (May-June 1960): 421-423.

Giffin, S.F. The Crisis Game: Simulating International Conflict . Garden City, N.Y.: Doubleday, 1965.

Livermore, W.R. The American Kriegsspiel , rev. ed. Boston: W.B. Clarke Co., 1898.

Lynch, W.H. "A Design Optimization for a Two Player Strategic Missile Game Incorporating Both Offensive and Defensive Missiles." Thesis, University of California, 1971.

Shephard, R.W. "Wargaming as a Technique in the Study of Operations Research Problems." Operational Research Quarterly 14 (June 1963): 119.

Taylor, J.L. "Development and Application of a Terminal Air Battle Model." Operations Research 7 (November-December 1959): 783-796.

Tiede, P.V. and Leake, L.A. " A Method for Evaluating the Combat Effectiveness of a Tactical Information System in a Field Army." Operations Research 19(3) (May-June 1971): 587-604.

F. BIBLIOGRAPHIES

1. GAMING LITERATURE

Bibliography of Games-Simulations For Teaching Economics and Related Subjects . New York: Joint Council on Economic Education, 1968.

Charles, C.L. and Stadsklev, R., eds. Learning With Games: An Analysis of Social Studies, Educational Games and Simulations . Education Resources Information Center (Social Studies/Social Sciences Education), 1973.

Computer Simulation: A Bibliography of Selected RAND Publications . Santa Monica: RAND Corporation, 1971.

Deacon, A.R.L. "Selected Bibliography; On Simulation Gaming and Related Topics." AMA Management Report No. 55 . American Management Association, 1961.

Duke, R.D. Bibliography for Gaming in Urban Research . The Institute for Community Development and Services. East Lansing, Mich.: Michigan State University, 1963.

Duke, R.D. and Schmidt, A.H. Operational Gaming and Simulation in Urban Research: An Annotated Bibliography . The Institute for Community Development and Services. East Lansing, Mich.: Michigan State University, 1965.

Hausrath, A.H. Venture Simulation in War, Business and Politics . New York: McGraw Hill , 1971.

Hogan, A.J. "Simulation. An Annotated Bibliography." Social Education 32 (March 1968): 242-244.

Jensen, I.M. Simulation/ Games. A Selected Bibliography for the Use of Educators/Administrators . Merrill Library and Learning Resources Program. Logan: Utah State University, 1971.

Kidder, S.J. Simulation Games: Practical References, Potential Use, Selected Bibliography . Centre for the Study of Social Organization of Schools. Baltimore: Johns Hopkins University, August 1971.

Loewenstein, L.K. Annotated Bibliography on Urban Games . Monticello, Ill.: Council of Planning Librarians, 1971.

Malcom, D.G. "Bibliography on the Use of Simulation in Management Analysis." Operations Research 8 (March-April 1960): 169-177.

Naylor, T.H. "Bibliography 19. Simulation and Gaming." Computing Reviews 10 (1969): 61-69.

Riley, V. and Young, J. Bibliography on War Gaming . Baltimore: Johns Hopkins University, 1957.

"Selective Bibliography on Simulation Games as Learning Devices." American Behavioral Scientist 10(3) (November 1966): 34-35.

Shubik, M. "Bibliography on Simulation, Gaming, Artificial Intelligence and Allied Topics." Journal of the American Statistical Association 55 (December 1960): 736-751.

Shubik, M. and Brewer, G.D. Reviews of Selected Books and Articles on Gaming and Simulations . Santa Monica: RAND Corp., June 1972.

Stoll, C.S. and Inbar, M., eds. "Social Simulation." American Behavioral Scientist 12 (July 1969): 1-47.

Syracuse University. Management Development Current Information Sources No. 1 . New York: Syracuse University, November 1967.

Syracuse University. Management Development Current Information Sources No. 17 . New York: Syracuse University, March 1968.

Tansey, P.J. and Unwin, D. "Sources in Simulation and Academic Gaming: An Annotated Bibliography." British Journal of Educational Studies 17 (June 1969): 193-208.

Taylor, J.L. Instructional Planning Systems a Gaming-Simulation Approach to Urban Problems . London: Cambridge University Press, 1971.

Thornton, B. Gaming Technique for City Planning . Monticello, Ill.: Council of Planning Librarians, 1971.

Twelker, P.A. and Layden, K. Educational Simulation/Gaming . Stanford, Palo Alto, Calif.: Stanford University, August 1972.

Twelker, P.A., ed. Instructional Simulation Systems: An Annotated Bibliography . Corvallis, Oregon: Continuing Education Publications, 1969.

Zuckerman, D.W. and Horn, R.E. The Guide to Simulation Games for Education and Training . Cambridge, Mass.: Information Resources Inc., 1970.

2. GAMES

Avedon, E.M. and Sutton-Smith, B. The Study of Games . New York: J. Wiley, 1971.

Bibliography of Games-Simulations For Teaching Economics and Related Subjects . New York: Joint Council on Economic Education, 1968.

Charles, C.L. and Stadsklev, R., eds. Learning With Games: An Analysis of Social Studies, Educational Games and Simulations . Education Resources Information Center (Social Studies/Social Sciences Education), 1973.

Coleman, J.S. The Role of Modern Technology in Relation to Simulation and Games For Learning . Washington: Academy for Educational Development Inc., 1970.

Eiloart, T. and Searle, N. "Business Games Off Shelf." Simulation 20, No. 2, (February 1973): 63.

Hausrath, A.H. Venture Simulation in War, Business and Politics . New York: McGraw Hill , 1971.

House, P.W., et al. National Gaming Council . Washington: Envirometrics Inc., April 17, 1970.

Klietsch, R.G.; Wiegman F.B.; and Powell, J.R. Directory of Educational Simulation, Learning Games and Didactic Units . St. Paul: Instructional Simulations, 1969.

McRaith, J.F. and Goeldner, C.R. "A Survey of Marketing Games." Journal of Marketing 26 (July 1962): 69-72.

"Selective Bibliography on Simulation Games as Learning Devices." American Behavioral Scientist 10 (3) (November 1966): 34-35.

"Simulation Games and Learning Behavior." American Behavioral Scientist 10 (November 1966): 1-36.

Steinwachs, B. A Selected List of Urban and Environmental Gaming/Simulations . Environmental Simulation Laboratory. Ann Arbor: Michigan University, 1970.

Twelker, P.A. "Simulation: State of the Field." Paper Presented at the Conference, Simulation: Stimulation for Learning, Boston, Mass., October 1968.

Wigderson, H.I. The Name of the Game Simulation Research Brief No 4 . Visalia, Calif.: ADAPT A PACE Supplementary Educational Center, June 1968.

Zuckerman, D.W. and Horn, R.E. The Guide to Simulation Games for Education and Training . Cambridge, Mass.: Information Resources Inc., 1970.

Zuckerman, D.W. and Horn, R.E. The Guide to Simulation Games for Education and Training . 2nd ed. Lexington, Mass.: Information Resources Inc., 1973.

3. GAMING GROUPS

Bibliography of Games-Simulations For Teaching Economics and Related Subjects . New York: Joint Council on Economic Education, 1968.

Coleman, J.S. The Role of Modern Technology in Relation to Simulation and Games For Learning . Washington: Academy for Educational Development Inc., 1970.

"Games Are Serious Business." The Canadian Personnel and Industrial Relations Journal 15 (November 1968): 41.

Jensen, I.M. Simulation/ Games. A Selected Bibliography for the Use of Educators/Administrators . Merrill Library and Learning Resources Program. Logan: Utah State University, 1971.

"Simulation Games and Learning Behavior." American Behavioral Scientist 10 (November 1966): 1-36.

Steinwachs, B. A Selected List of Urban and Environmental Gaming/Simulations . Environmental Simulation Laboratory. Ann Arbor: Michigan University, 1970.

Twelker, P.A. and Layden, K. Educational Simulation/Gaming . Stanford, Palo Alto, Calif.: Stanford University, August 1972.

Zuckerman, D.W. and Horn, R.E. The Guide to Simulation Games for Education and Training . Cambridge, Mass.: Information Resources Inc., 1970.

UNIVERSITY GRANT PROGRAM RESEARCH REPORTS

RAPPORT DE RECHERCHE SUR LE PROGRAMME DE SUBVENTIONS AUX UNIVERSITES

	AUTHOR(S)/AUTEUR(S)	UNIVERSITY/UNIVERSITÉ	REPORT TITLE/TITRE DE L'OUVRAGE
1.	I.A. Litvak C.J. Maule	Department of Economics, Carleton University.	Canadian Entrepreneurship: A Study of Small Newly Established Firms, October, 1971.
2.	Harold Crookell	School of Business Administration, University of Western Ontario.	The Transmission of Technology Across National Boundaries, February, 1973.
3.	M.H.E. Atkinson	Faculty of Graduate Studies, University of Western Ontario.	Factors Discriminating Between Technological Spin-Offs and Research and-Development Personnel, August, 1972.
4.	R.M. Knight	School of Business Administration, University of Western Ontario.	A Study of Venture Capital Financing in Canada, June, 1973.
5.	Blair Little R.G. Cooper R.A. More	School of Business Administration, University of Western Ontario.	The Assessment of Markets for the Development of New Industrial Products in Canada, December, 1971.
6.	F. Zabransky J. Legg	School of Business Administration, University of Western Ontario.	Information and Decision Systems Model for PAIT Program, October, 1971.
7.	K.R. MacCrimmon W.T. Stanbury J. Bassler	Faculty of Commerce and Business Administration, University of British Columbia.	Risk Attitudes of U.S. and Canadian Top Managers, September, 1973.
8.	James C.T. Mao	Faculty of Commerce and Business Administration, University of British Columbia.	Computer Assisted Cash Management in a Technology-Oriented Firm, March, 1973.
9.	J.W.C. Tomlinson	Faculty of Commerce and Business Administration, University of British Columbia.	Foreign Trade and Investment Decisions of Canadian Companies, March, 1973.
10.	G. Kardos	Faculty of Engineering, Carleton University.	Case History of Three Innovations: Webster Mfg. (London) Ltd; Spectrac Limited, and The Snotruk, 1973.
11.	I.A. Litvak C.J. Maule	Department of Economics, Carleton University.	A Study of Successful Technical Entrepreneurs in Canada, September, 1972.
12.	Y. Allaire, J.M. Toulouse	Faculty of Management Sciences, University of Ottawa.	Psychological Profile of French-Canadian M.B.A. Students: Consequences for a Selection Policy, December, 1972.
13.	Carl Prézeau	Faculté d'administration, Université de Sherbrooke.	The Portfolio Effect in Canadian Exports, May, 1973.
14.	M.R. Hecht J.P. Siegel	Faculty of Management Studies, University of Toronto.	A Study of Manufacturing Firms in Canada: With Special Emphasis on Small and Medium Sized Firms, December, 1973.
15.	Blair Little	School of Business Administration, University of Western Ontario.	The Development of New Industrial Products in Canada. (A Summary Report of Preliminary Results, Phase I) April, 1972.
16.	A.R. Wood J.R.M. Gordon R.P. Gillin	School of Business Administration, University of Western Ontario.	Comparative Managerial Problems in Early Versus Later Adoption of Innovative Manufacturing Technologies, (Six Case Studies), February, 1973.
17.	S. Globerman	Faculty of Administrative Studies, York University.	Technological Diffusion in Canadian Manufacturing Industries, April, 1974.
18.	M. James Dunn Boyd M. Harnden P. Michael Maher	Faculty of Business Administration and Commerce, University of Alberta.	An Investigation into the Climate for Technological Innovation in Canada, May, 1974.
19.	K.R. MacCrimmon A. Kwong	Faculty of Commerce and Business Administration, University of British Columbia.	Measures of Risk Taking Propensity, July, 1972.
20.	I.A. Litvak C.J. Maule	Department of Economics, Carleton University.	Climate for Entrepreneurs: A Comparative Study, January, 1974.

	AUTHOR(S)/AUTEUR(S)	UNIVERSITY/UNIVERSITE	REPORT TITLE/TITRE DE L'OUVRAGE
21.	J. Robidoux Gerard Garnier	Faculte d'administration, Université de Sherbrooke.	Factors of Success and Weakness Affecting Small and Medium-Sized Manufacturing Businesses In Quebec, Particularly those Businesses using Advanced Production Techniques, December, 1973. Facteurs de Succes et Faiblesses des Petites et Moyennes Entreprises Manufacturieres au Québec, Specialement des Entreprises Utilisant des Techniques de Production Avancees, decembre, 1973.
22.	I. Vertinsky K. Hartley	Faculty of Commerce and Business Administration, University of British Columbia.	Project Selection in Monolithic Organizations, August, 1974.
23.	Yvan Allaire J.M. Toulouse	Faculty of Management Sciences, University of Ottawa.	A Comparative Study of the Values and Needs of French-Speaking and English-Speaking M.B.A. Students, August, 1973.
24.	Jean Robidoux	Faculte d'administration, Université de Sherbrooke.	Analytical Study of Significant Traits Observed Among a Particular Group of Inventors in Quebec, August, 1974. Etude Analytique de Traits Significatifs Observes Chez un Groupe Particular D'Inventeurs au Québec, Août, 1974.
25.	Blair Little	School of Business Administration, University of Western Ontario.	Risks in New Product Development, June, 1972.
26.	Blair Little R.G. Cooper	School of Business Administration, University of Western Ontario.	Marketing Research Expenditures: A Descriptive Model, November, 1973.
27.	Blair Little	School of Business Administration, University of Western Ontario.	Wrecking Ground for Innovation, February, 1973.
28.	J.W.C. Tomlinson	Faculty of Commerce and Business Administration, University of British Columbia.	Foreign Trade and Investment Decisions of European Companies, June, 1974.
29.	Blair Little	School of Business Administration, University of Western Ontario.	The Role of Government in Assisting New Product Development, March, 1974.
30.	R.G. Cooper	Faculty of Management, McGill University.	Why New Industrial Products Fail, January, 1975.
31.	M.E. Charles D. MacKay	The C.E.R.C.L. Foundation, 200 College Street, Toronto, Ontario. M5S 1A4	Case Studies of Industrial Innovation in Canada, February, 1975.
32.	M.R. Hecht	Faculty of Management Studies, University of Toronto.	A Study of Manufacturing Firms in Canada: With Emphasis on Education of Senior Officers, Types of Organization and Success, March, 1975.
33.	I.A. Litvak C.J. Maule	Department of Economics, Carleton University.	Policies and Programmes for the Promotion of Technological Entrepreneurship in the U.S. and U.K.: Perspectives for Canada, May, 1975.
34.	R.R. Britney E.F.P. Newson	School of Business Administration, University of Western Ontario.	The Canadian Production/Operations Management Environment: An Audit, April, 1975.
35.	R.F. Morrison P.J. Halpern	Faculty of Management Studies, University of Toronto.	Innovation in Forest Harvesting by Forest Products Industries, May, 1975.
36.	J.C.T. Mao	Faculty of Commerce and Business Administration, University of British Columbia.	Venture Capital Financing for Technologically-Oriented Firms, December, 1974.
37.	J.W.C. Tomlinson C.S. Willie	Faculty of Commerce and Business Administration, University of British Columbia.	Guide to the Pacific Rim Trade and Economic Database, September, 1975.

	AUTHOR(S)/AUTEUR(S)	UNIVERSITY/UNIVERSITÉ	REPORT TITLE/TITRE DE L'OUVRAGE
38.	D.A. Ondrack	Faculty of Management Studies, University of Toronto.	Foreign Ownership and Technological Innovation in Canada: A Study of the Industrial Machinery Sector of Industry, July, 1975.
39.	James C.T. Mao	Faculty of Commerce and Business Administration, University of British Columbia.	Lease Financing for Technology-Oriented Firms, July, 1975.
40.	M. James Dunn Boyd M. Harnden P. Michael Maher Michael J. Vertigan John A. Watson	Faculty of Business Administration and Commerce, University of Alberta.	An Investigation into the Climate for Technological Innovation in Canada. Stage II - A Fundamental Research Effort Directed Towards the Design of an Experimental and Management Development Program for Research and Development Project Selection Decisionmakers, July, 1975.
41.	Gary A. Sheehan Donald H. Thain Ian Spencer	School of Business Administration, University of Western Ontario.	The Relationships of Long Range Strategic Planning to Firm Size and to Firm Growth, August, 1975.