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Market Assessment Expenditures In Industrial New Product Ventures

Robert Gravlin Cooper

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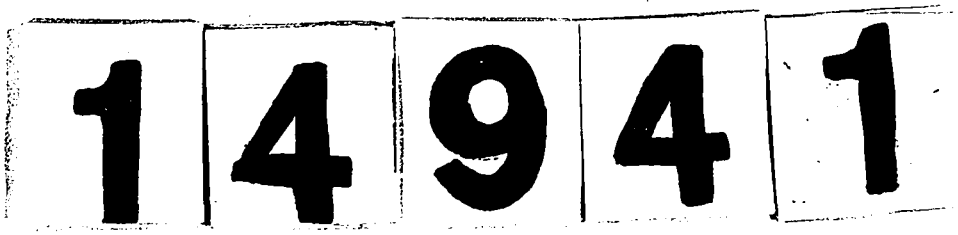

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MARKET ASSESSMENT EXPENDITURES IN INDUSTRIAL NEW PRODUCT VENTURES

by

Robert G. Cooper

School of Business Administration

Submitted in partial fulfillment

of the requirements for the degree of

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ABSTRACT

This thesis focusses on the amount of market assessment which managers undertake during the development of new industrial products. The aims of the research are to determine the amount of assessment conducted in new product projects, and to identify those factors which influenced this amount. A further goal is the development of a prescriptive guide to assist managers in their market assessment expenditure decisions.

The first major hypothesis of the study is that the amount of market assessment conducted in new product ventures is determined by variables which describe the amounts at stake, the uncertainties and probabilities, and the costs of market information faced in the venture. A second hypothesis is that better practice projects are characterized by more market assessment.

The empirical data was based on 118 successful new product ventures undertaken by Canadian industrial goods firms. Managers' new product market assessment expenditures were found to be fairly predictable, and the hypothesized Behavioral Model of the research was supported. Seven variables which characterize the new product situation were found to be the key determinants of market assessment expenditures and average decision rule of managers was reduced to simple mathematical descriptive expression. Substantially higher levels of market assessment were conducted in better practice projects for equivalent new product situations.

A preliminary prescriptive guide to new product market assessment expenditures is presented. The major implications of the findings of the research to business practitioners and public policy formulators are reported.

ACKNOWLEDGEMENTS

The author is indebted to many people, whose help made this thesis possible. Special thanks is due my thesis advisor, Professor Blair Little. It was he who first aroused my interest in new product development and market assessment, while the specific research topic and much of the data came from Professor Little's own study. At the same time he gave much of his time and energy in assisting me throughout every phase of this research and the writing of the dissertation.

The Department of Industry, Trade and Commerce (Canada), and in particular, Dr. Allen Vanterpool of that department, are gratefully acknowledged. The DITC provided the research funds to Professor Little which helped finance this work. I would also like to thank the Canada Council for personal financial assistance in the form of a three year Doctoral Fellowship.

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My wife, Linda, deserves much of the credit for my completing this dissertation. Besides giving me constant encouragement, she also assisted in numerous ways during the research and in the writing of the dissertation. Without her help and support, this final document would not have been possible.

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1.1 OUTLINE OF THE PROBLEM

1.1.1 Introduction

Technological innovations and the resultant development of new and improved products are essential for the survival and growth of companies and individual industries.[1] During the new product development process, a knowledge of the market is vital to the successful development and introduction of the new product. This research focusses on the amount of market assessment which firms undertake during the development of new industrial products. The aim of the study is to provide an understanding of how managers decide what to spend on market assessment in a new product venture, and also to contribute to the improvement of the new product development process, by focusing on the role of market assessment.

1.1.2 The Problem

The lack of market assessment represents a major problem in industrial new product development. Inadequate market knowledge ranked first amongst the major reasons cited by managers of industrial goods firms for their past new product failures.[2] In spite of the need for more and better market assessment in new product development,

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[1]An extensive general discussion of this topic is given by: L. Silk, *The Research Revolution* (New York: McGraw Hill Book Co., 1960)

[2]National Industrial Conference Board, *Why New Products Fail*, The Conference Board Record (New York: NICB, 1964), p. 11.

the behavior of industrial goods firms reveals that a relatively small proportion of resources is allocated to the market assessment function.[3] There is a need therefore to investigate the decision to undertake market assessment, and to develop prescriptive guides for managers in their new product market assessment decisions.

New product development is an important endeavor in industrial product companies. Producers of industrial goods are increasingly dependent on the development of new products to remain competitive, to ensure corporate growth and to offset the effects of product obsolescence.[4] In a recent survey of 173 industrial product manufacturers, half the firms reported that between ten percent and thirty percent of their current sales were attributed to the sales of products first marketed by them in the last five years.[5]

While new product development is crucial to the growth of many firms, it also represents major risks in terms of investment and uncertainties. Investments in new product development are substantial – industrial firms in the United States were estimated to have spent $20 billion on R & D in 1971, while the total expenditure on R & D in the U.S. was estimated to be $27.8 billion or approximately 2.7 percent of the U.S. Gross National Product.[6] In Canada, R & D expenditures in 1972 were

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[3]Blair Little, Robert G. Cooper and Roger A. More, "Putting the Market into Technology to Get Technology into the Market," *Business Quarterly* (Summer, 1972), pp. 62-69.

[4]National Industrial Conference Board, *Appraising the Market for New Industrial Products*, Studies in Business Policy #123 (New York: NICB, 1967), p. 1.

[5]National Industrial Conference Board, *The Marketing Executive Looks Ahead*, Experiences in Marketing Management #13 (New York: NICB, 1967).

[6]National Science Foundation, *National Patterns of R & D Resources, 1953-71* (Washington: NSF, 1971), pp. 1-17.

estimated to be $1.8 billion, or somewhat less than two percent of the G.N.P.[7] At the same time, the high rate of new product failure points to the uncertainties involved in new product development. A study of large and well-managed U.S. companies indicates that out of every ten products which emerge from R & D, five fail in the product and market tests, and only two become commercial successes.[8] Moreover, seven out of eight hours devoted to the development of technical products by scientists and engineers are spent on products that fail at some stage of the process.[9]

The high risks involved in technological innovation are of particular concern to both the companies involved and also to the governments of industrialized nations. In some instances, these risks may reduce the returns on R & D to a dangerously low level, thereby discouraging further expenditures in R & D.

Inadequate market information is a major underlying cause of this high new product failure rate. In one major survey of new product development, managers typically voiced less concern with their companies' technical research and development problems, than with the need for better marketing planning and more effective use of marketing research.[10] Among the six major reasons cited by managers for industrial product failure, five were directly attributable to a lack of market assessment or poor market information.[11] In order of decreasing importance, these reasons were: inadequate market knowledge, faulty product performance, misdirected sales and marketing efforts, actions of competitors, product obsolescence, and timing of introduction.

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[7]Statistics Canada, *Canada Year Book 1972* (Ottawa: 1972), pp. 436-440.

[8]Booz Allen and Hamilton, *The Management of New Products* (New York: 1960).

[9]Booz Allen and Hamilton.

[10]NICB, *Appraising the Market*, p. 5.

[11]NICB, *Why New Products Fail*, p. 11.

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[7]Statistics Canada, *Canada Year Book 1972* (Ottawa: 1972), pp. 436-440.

[8]Booz Allen and Hamilton, *The Management of New Products* (New York: 1960).

[9]Booz Allen and Hamilton.

[10]NICB, *Appraising the Market*, p. 5.

[11]NICB, *Why New Products Fail*, p. 11.

The high failure rates of new industrial products have forced many managers to look for ways to reduce the risks inherent in the development and marketing of new industrial products.[12] Marketing research tools have been suggested as a means of reducing the possibility of new product failure. However the billions spent on technical research (R & D) stand in striking contrast to management's far lesser interest in marketing research.[13]

This research focusses on one of the major deficiencies of the industrial new product development process – the lack of market assessment. In particular, the research investigates the amount of market assessment which firms undertake in developing a new industrial product, and those factors which appear to influence the amount of assessment they conduct. An aim of this research is also to contribute to the development of prescriptive guides which will help managers determine or justify expenditures on market assessment.

1.1.3 Deficiencies in Normative Approaches

At present there are no widely accepted procedures for evaluating the returns from market assessment.[14] Normative approaches, which proport to determine how much a manager should spend in gathering market information, are inadequate because:

1. they over-simplify the decision situation;
2. they suffer from conceptual errors;
3. they require estimates and values frequently unavailable;
4. they meet management resistance in their implementation.

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[12]NICB, *Appraising the Market*, p. 1.

[13]W. T. Jerome II, *Executive Control* (New York: John Wiley & Sons, 1961), p. 77.

[14]Ralph L. Day, "Optimizing Market Research Through Cost Benefit Analysis," *Business Horizons*, Vol. 9 (Fall, 1966), pp. 45-54.

The intangible nature of the benefits of market assessment, the difficulty in placing a value on these benefits, and the lack of adequate prescriptive guides are probably major reasons for managers' reluctance to undertake more market assessment during new product projects.[15] This section briefly reviews the more familiar normative approaches to determining optimal marketing research expenditures, outlines the major deficiencies of these techniques, and suggests why these normative approaches are seldom implemented.

Normative approaches to information acquisition expenditures may be generally classed as either objectives and task methods or valuation of information techniques. The objectives and task approach requires the manager to first set his information objectives, and then to formulate a research plan to achieve the desired objectives. Most students of marketing research are instructed in the objectives and task method.[16] Specific examples of the objectives and task approach include checklists, to aid the manager in the formulation of research objectives and the development of a research plan,[17] and the payoff matrix, which helps to target the research effort.[18] However, the objectives and task approach falls short of addressing the problem of optimal expenditure, since it is always assumed that the objectives are worth the cost of

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[15]Little, Cooper and More, pp. 62-69.

[16]See for example: Harper W. Boyd and Stewart H. Britt, "Making Marketing Research More Effective by Using the Administrative Process," *Journal of Marketing Research,* Vol. 13 (February, 1965), pp. 13-19; see also: American Marketing Association, *Marketing Research Techniques Series,* #1-7 (Chicago: 1958).

[17]See for example: E. L. Eldridge, "Check List for Eldridge Marketing Plan," *Marketing Management and Administrative Behavior,* ed. Stewart H. Britt and Harper W. Boyd (New York: McGraw Hill Book Co., 1963), pp. 194-202.

[18]Boyd and Britt, "Making Marketing Research More Effective," pp. 13-19.

obtaining them.[19]

The valuation of information approach to market assessment recognizes that information has both a dollar value and a cost, and attempts to assess the benefits versus costs of information. Most quantitative normative approaches may be classed as information valuation techniques.[20]

A direct and simple method for valuing information is the cost of a wrong decision technique: "the cost of not doing market research is the cost of making a mistaken decision times the difference between the chances of making such a mistake with and without the information the research may supply."[21] However it may not be possible for a manager to estimate a single value to describe the cost of a wrong decision.[22] Moreover, no method for revising prior probabilities in the light of the market information is provided.

The difference between the posterior cost of uncertainty and the prior cost of uncertainty is proposed as a measure of the value of information.[23] The costs of uncertainty are determined mathematically by combining management's prior and

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[19]Dean criticizes the objectives and task approach in the context of setting advertising expenditures. See: Joel Dean, "How Much to Spend on Advertising," *Harvard Business Review* (1951), pp. 65-74.

[20]Some normative approaches have been previously reviewed. See: James H. Myers and A. Coskun Samli, "Management Control of Marketing Research," *Journal of Marketing Research,* Vol. 6 (August, 1969), pp. 267-277; see also: Day, pp. 45-54.

[21]Ralph S. Alexander, "The Marketing Manager's Dilemma," *Journal of Marketing,* Vol. 29 (April, 1965), pp. 18-21.

[22]Myers and Samli, pp. 267-277.

[23]Lawrence Harris, "A Decision-theoretic Approach on Deciding When a Sophisticated Forecasting Technique is Needed," *Management Science,* Vol. 13, No. 2 (October, 1966), pp. B-66 to B-69. A modification to this technique is proposed by: Joel Owen, "A Criterion for Investing in Information," *Management Science,* Vol. 14, No. 2 (August, 1967), pp. B-715 to B-720.

posterior distributions with a quadratic loss function. However, the simplifying assumptions of the model – normal distributions for prior probabilities and additional information, and the form of the loss function – limit the practical application of the method in new product situations.

A marketing research expenditure model, based on Bayesian analysis, represents a conceptually rigorous method of determining optimal market research expenditures.[24] Bayesian methods rely on the maximum expected value choice criterion, and utilize preposterior analysis to determine optimal acts conditional upon receipt of new information.[25] Operationally, however, Bayesian methods have proved difficult to implement due to the complexity of real world problems, the unfamiliar logic and language of the method, and the reluctance of managers to estimate probabilities under conditions of uncertainty.[26]

A number of modifications and extensions of the basic Bayesian approach to information valuation have been proposed. Edwards' optimal stopping rule, which utilizes a dynamic form of bayesian analysis, permits the decision maker to decide after the receipt of each piece of information, whether or not to seek the next one.[27] How-

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[24]Frank M. Bass, "Marketing Research Expenditures: A Decision Model," *Journal of Business*, Vol. 36 (January, 1963), pp. 77-90.

[25]See for example: Robert Schlaiffer, *Probability and Statistics for Business Decisions* (New York: McGraw Hill Book Co., 1959); also: Howard Raiffa and Robert Schlaiffer, *Applied Statistical Decision Theory* (Boston: Division of Research, Graduate School of Business Administration, Harvard University), chap. 1.

[26]Rex V. Brown, "Do Managers Find Decision Theory Useful?" *Harvard Business Review* (May, June, 1970), pp. 78-79.

[27]Ward Edwards, "Optimal Strategies for Seeking Information: Models for Statistics, Choice Reaction Times, and Human Information Processing," *Journal of Mathematical Psychology*, Vol. 2 (1965), pp. 312-329.

ever the necessary assumptions – a two action, two state problem – limit the practical applications of the technique. Another modification of formal decision theory is Day's cost-benefit analysis, which attempts to reduce the computational work in the Bayesian model.[28] However, Day has made a conceptual error in his model, and his method yields erroneous results.[29]

Qualitative approaches to determining marketing research expenditures by information valuation generally state in words what formal decision analysis does mathematically.[30] These latter approaches do not provide the manager with a rigorous method of determining optimal research expenditures.

Each of the normative approaches, described above, has its merits, and considered together, they represent a fruitful beginning to the solution of the marketing research manager's dilemma. Nevertheless, the manager still lacks a rigorous and operational method for determining and justifying his market assessment expenditures. The result is that, in practice, little scrutiny is given to the need for market research, the value of the research, and the contribution it can make to the marketing effort.[31]

One of the major motivations for undertaking the present research is the lack of an operational method for determining appropriate market assessment expendi-

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[28]Day, pp. 45-54.

[29]To obtain the value of imperfect information, Day multiplies the expected value of perfect information (EVPI) by the probability of obtaining perfect information. However the value of imperfect information should equal the probability of perfect information times the EVPI (Day's definition) plus the value of totally wrong information (a negative quantity) times its probability of occurring.

[30]See for example: Robert H. Hayes, "Qualitative Insights from Quantitative Methods," *Harvard Business Review* (July, August, 1969), pp. 108-117. See also: Robert D. Buzzel, Donald F. Cox and Rex V. Brown, *Marketing Research and Information Systems: Text and Cases* (New York: McGraw Hill Book Co., 1969), pp. 610-611.

[31]Myers and Samli, pp. 267-277.

tures. This deficiency contributes to the low level of market assessment in new product development. An aim of the research is the development of prescriptive guides from a study of current practice of market assessment.

1.2 OBJECTIVES OF THE STUDY

In this section, the objectives of the research are restated in a more rigorous manner. The ultimate objective of the study is to contribute to the improvement of the new product development process in industrial goods firms by studying the amount of market assessment in the innovation process. There is a need for operational methods to evaluate the decision to conduct market assessment in new product development, and to determine appropriate amounts of market assessment for various new product situations. A first step towards the development of a prescriptive guide is a better understanding of current practice regarding the amounts of assessment conducted during industrial new product development. The specific objectives of this study are therefore:

1. to determine the amount of market assessment currently conducted by firms in industrial new product ventures;
2. to determine which factors characterizing a new product situation appear to influence the amount of assessment undertaken;
3. to develop an empirical and quantitative descriptive model which relates the amount of assessment conducted by these firms to variables which describe the new product situations faced;
4. to derive normative implications, and if possible, a preliminary prescriptive guide, to assist managers in their market assessment expenditure decisions in industrial new product ventures.

To achieve these objectives, the research specifically addresses the following questions:

1. How much market assessment do industrial goods firms undertake during the development of new industrial products?
2. What are the relationships between the amount of assessment conducted and the new product situational variables (that is, variables which describe the new product situation)?
3. Can a group of "better practice" projects or firms be identified, in which the amounts of assessment undertaken might yield normative implications and perhaps a preliminary prescriptive guide for managers?

1.3 DEFINITIONS OF TERMS

This section briefly defines some terms which have appeared in previous sections. The phrase industrial products refers to goods which are marketed to buyers who use them in connection with the goods and services they in turn produce. It is constrasted with consumer products, where goods are sold (either directly or through middlemen) to buyers who use them for the personal satisfaction of themselves and their families.[32]

New products, for the purpose of this study, are products new to the selling company, even though they already may be established in the market by another firm. Johnson and Jones provide a convenient classification system (technical newness

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[32]Based on a definition by: E. R. Corey, *Industrial Marketing* (Englewood Cliffs, N. J.: Prentice Hall, 1962).

or market newness) which serves as the criterion of newness in this study.[33]

Market assessment activities are defined as the set of activities directed towards gathering information about the marketplace to facilitate management decisions. These activities might include, for example, an examination of market statistics, visits to potential customers and others, field tests of prototypes, test marketing, and surveys. Alternate terms used in this study include market search, search activities, and information acquisition.

1.4 THE MODELS DEVELOPED FOR THE RESEARCH

One objective of the research is the identification and description of the relationships between the amount of market assessment conducted in new product projects and the important determinants of this amount. This objective is achieved by developing an empirical model based on actual management performance – the Average Manager Model – which relates amount of assessment which managers undertake to variables which characterize the new product situation.

In order to derive this empirical model, a hypothesized model describing the decision to undertake market assessment is first developed. This model is called the Behavioral Model, and postulates that the amount of market assessment undertaken is related to certain variables which describe the new product situation. The Behavioral Model identifies the relevant variables which are measured in this research, and also yields a set of hypotheses which are tested during the study. The Average Manager Model and the Behavioral Model are therefore closely related – the Behavioral Model is a descriptive model in hypothesized form, while the Average Manager Model is this same

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[33] S. C. Johnson and C. Jones, "How to Organize for New Products," *Harvard Business Review* (May, June, 1957), p. 52.

descriptive model, but modified and tested with empirical data.

An important step in the logical development of the hypothesized Behavioral Model is the derivation of a simple normative decision rule – called the Normative Decision Model – which predicts the amount of assessment a manager should undertake for a given new product situation. Evidence of a qualitative consistency between actual and optimal expenditures on information acquisition suggests that the Normative Decision Model provides a useful base for the development of the Behavioral Model. The sequence of model development and relationships between the models is shown in Figure 1.1.

1.5 AN OUTLINE OF THE RESEARCH

This chapter has outlined a major problem area in industrial new product development – a lack of market assessment. A review of normative techniques for determining marketing research expenditures reveals the reasons why these methods have not gained widespread acceptance. The specific research objectives and the questions addressed in the research were presented.

In Chapter II, a review of descriptive findings in the study of information acquisition suggests that a normative search model is a useful base upon which to build a descriptive model. The Normative Decision Model is developed in this chapter.

In Chapter III, the hypothesized Behavioral Model is developed. The model proposes that the amount of market assessment conducted in a new product project is determined by certain variables which describe the new product situation.

Chapter IV focusses on the possible normative implications of the research, and suggests that the Behavioral Model, with empirically derived coefficients, may provide useful inputs to managerial decisions. In addition, criteria for identifying "better practice" projects are derived. The aim is the development of aprescriptive guide based on assessment expenditures associated with "better practice" projects.

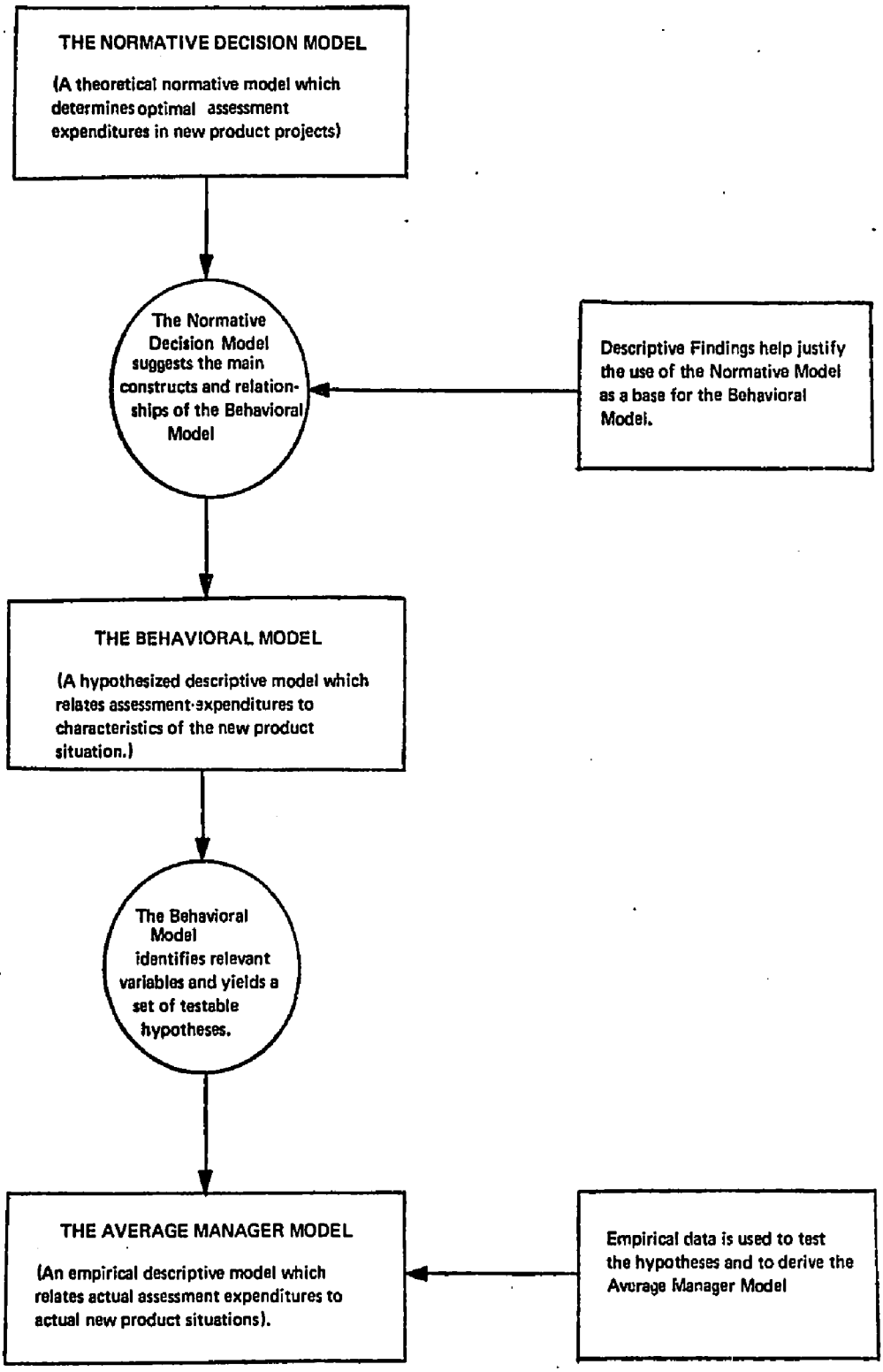

Figure 1.1. The Roles of Models Developed for the Research.

Chapter VI outlines the methodology of the research. The data collection phase and the data analysis methods are reviewed. In Chapter VII, the major empirical findings of the research are presented, while Chapter VIII outlines the conclusions and implications of the research.

CHAPTER II

DEVELOPMENT OF THE NORMATIVE DECISION MODEL

2.1 INTRODUCTION

The development of a simplified normative model for determining optimal market research expenditures in a new product setting is outlined in this chapter. The Normative Decision Model is essentially a Bayesian information acquisition model, which is adapted to describe the information purchase problem faced during the new product development process. This model predicts how much a manager ought to spend on market assessment depending upon the new product choice situation faced.

The Normative Decision Model is the first step in the derivation of the hypothesized descriptive model for the research – the Behavioral Model, presented in the next chapter. The Normative Decision Model permits the study of relationships between the optimal amount of assessment and its determinants: the main constructs of the Normative Decision Model become the bases of the Behavioral Model, while the optimal expression of the Normative Decision Model, while not directly used in the Behavioral Model, does suggest the directions of the behavioral relationships.

The role of the Normative Decision Model in this development is justified by research evidence in both the field of consumer search behavior and experimental psychology. Studies in these areas reveal that actual search activities – measured by the amount of search – are qualitatively consistent with the predictions of a Bayesian information model.

The present chapter begins with an overview of the Bayesian information

model. Next, the use of a Bayesian model as the basis for descriptive studies of search behavior is justified by reviewing the two main areas where information acquisition by decision-makers has been extensively researched. Finally, the chapter presents the development of the Normative Decision Model – a simplified Bayesian information acquisition model – which predicts optimal levels of market assessment expenditures. Figure 2.1 outlines the sequence of topics covered in the development of the Behavioral Model, and indicates the function of the Normative Decision Model in this process.

2.2 OVERVIEW OF THE BAYESIAN INFORMATION ACQUISITION MODEL

Bayesian methods permit the decision-maker to place a value on information before the information is obtained – the expected value of information – and enable the decision-maker to decide whether the information is worth the cost of obtaining it.[1] The Bayesian approach to decision-making utilizes the expected value criterion in selecting the preferred option. When it is possible to obtain additional information prior to acting, the decision-maker looks ahead to the possible outcomes of his search, and asks himself how he would revise his original probability estimates contingent on his search results. He also determines which act is optimal in the event of each search outcome.

This preposterior analysis – looking ahead and planning acts contingent on search results – is made possible by the use of Bayes' Theorem, which provides

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[1]Portions of this section are paraphrased from the following sources: Frank M. Bass, "Marketing Research Expenditures: A Decision Model, *Journal of Business*, Vol. 36 (January, 1963), pp. 77-90; also R. D. Buzzell, D. F. Cox, and R. V. Brown, *Marketing Research and Information Systems: Text and Cases* (New York: McGraw-Hill, 1969), Chap. 11. A complete discussion of Bayesian methods is provided by: Howard Raiffa and Robert Schlaiffer, *Applied Statistical Decision Theory* (Boston: Division of Research, Graduate School of Business Administration, Harvard University).

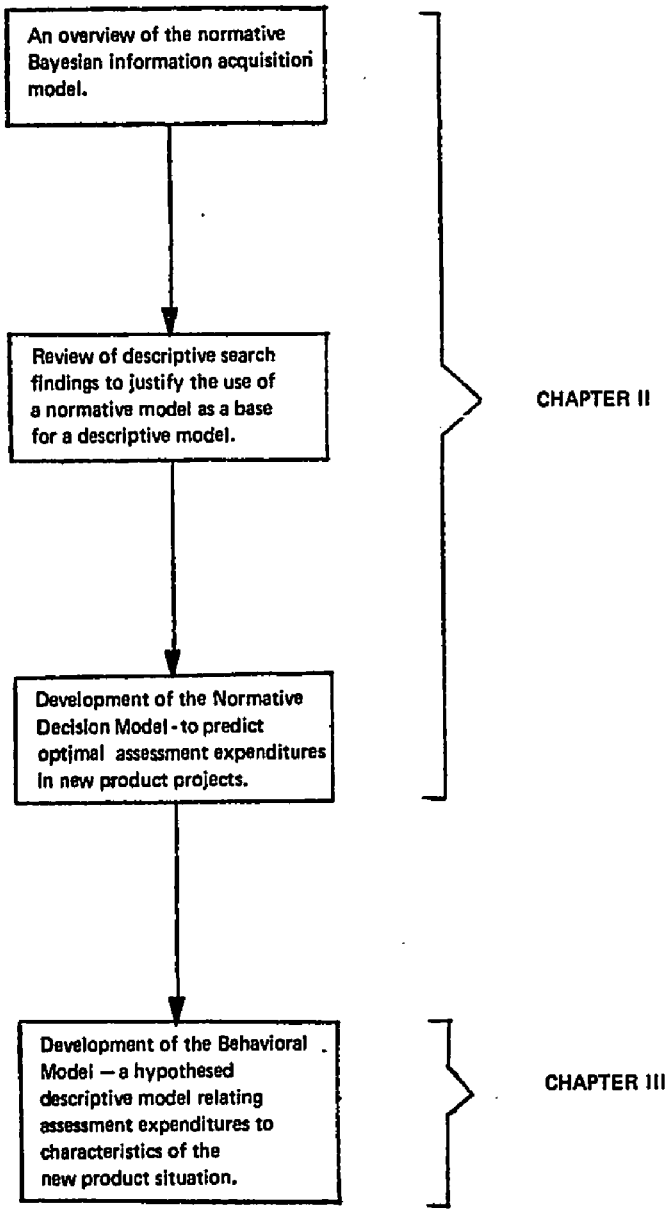

Figure 2.1. Sequence of Steps in the Development of the Behavioral Model.

a rigorous technique for revising prior probabilities given new information. The expected value of a given piece of information therefore becomes the difference between the expected value of the results of decisions made with the information and the expected value of the results of the decisions made without the information. The main determinants of the optimal amount of information are the cost of information, the expected value of information, the prior probability distributions, and the consequences of outcomes.

2.3 DESCRIPTIVE STUDIES OF INFORMATION ACQUISITION

The findings from research into consumer behavior and experimental studies of information acquisition, which are outlined in this section, reveal that the Bayesian normative model provides a most appropriate base for the derivation of a hypothesized descriptive model for the present research. These studies identified the main constructs which determined the amount of search undertaken by decision-makers: the cost of information, the value of information, the probabilities and uncertainties of the situation, and the values of consequences. These constructs are consistent with those of a Bayesian model.[2] Moreover, the qualitative agreement between actual amounts of information seeking and normative levels suggests that the Bayesian model is useful in predicting the types and directions of relationships in the development of a descriptive model.

2.3.1 Consumer Search Behavior

Studies into consumer search activities have led to the formulation of theories

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[2]See Section 2.2 of this chapter.

and generalizations about the amount and type of information consumers seek prior to making a purchase decision. The major determinants of the amount and type of information consumers seek during the purchase process are:[3]

1. the value of external search (as perceived by the decision-maker);
2. the perceived cost of external search.

The perceived cost of external search is determined by decision delay, time, money and psychological costs. The perceived value of external search is affected by the amount of stored information, the appropriateness of the stored information, the ability to recall the stored information, and the degree of physical, financial and social risk perceived by the consumer.

A major component of the perceived value of search is the perceived risk associated with the outcomes of a purchase decision. Cox and Bauer suggest that a buyer is likely to seek and use information in order to reduce the risk associated with the formation and satisfaction of his buying goals:

The amount of perceived risk in any behavioral act is a function of two factors:

1. the amount that would be lost (that which is at stake) if the consequence of the act were not favorable;
2. the individual's subjective feeling of uncertainty that the consequence will be favorable.[4]

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[3]An extensive review of the factors which influence the amount and type of information seeking by consumers is given by: J. F. Engle, D. T. Kollat and R. D. Blackwell, *Consumer Behavior* (New York: Holt, Rinehart and Winston, 1968), pp. 380-388. Portions of this paragraph are paraphrased from Engle, Kollat and Blackwell.

[4]Donald F. Cox, "Risk Handling in Consumer Behavior – An Intensive Study of Two Cases," *Risk Taking and Information Handling,* ed. D. F. Cox (Boston: Division of Research, Graduate School of Business Administration, Harvard University), pp. 34-81. The concept of risk and consumer search effort was originally proposed by: Raymond Bauer, "Consumer Behavior as Risk Taking," *Dynamic Marketing for a*

The implications of consumer search theory and findings to the present research originate from the proposition that the amount of search undertaken by a consumer is related to four constructs – the amounts at stake, the uncertainties of the situation, the value of information and the cost of search – while the directions of effect in the descriptive cases are qualitatively consistent with the predictions of a Bayesian model.

2.3.2 Experimental Studies

The topic of consistency between actual and Bayesian behavior in information acquisition is pursued in experimental research. Experimental studies into information acquisition generally focus on the amount and type of information seeking a decision-maker undertakes prior to making decisions.[5] Most of these studies have been set in the context of a normative or Bayesian framework. Researchers have typically manipulated rationally selected variables – variables suggested by a Bayesian analysis – to determine their impact on the amount of information a subject purchases. The findings are generally reported in terms of the deviations between actual and ideal behavior.

The research findings generally concur that, in experimental choice situations, individuals are sensitive to variations of rationally selected experimental variables, and in the direction a Bayesian model would predict. Most experimental evidence indicates

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Changing World, Proceedings of the 43rd Conference of the American Marketing Association, ed. R. S. Hancock (1960), pp. 389-398.

[5]The summaries of experimental studies and findings outlined in this section are taken from a number of extensive reviews in the area of information acquisition: Ward Edwards, "Dynamic Decision Theory and Probabilistic Information Processing," *Human Factors,* Vol. 4 (April, 1963), pp. 59-73. Also: Cameron R. Peterson and Lee Roy Beach, "Man as an Intuitive Statistician," *Psychological Bulletin,* Vol. 68, No. 1 (1967), pp. 29-46. Also: P. E. Green, P. J. Robinson and P. T. Fitzroy, *Experiments on the Value of Information in Simulated Marketing Environments* (Boston: Allyn and Bacon, 1967), pp. 5-9. Also: Ramon L. Hershman and J. R. Levine, "Deviations from Optimum Information-Purchase Strategies in Human Decision-Making," *Organizational Behavior and Human Performance;* Vol. 5 (1970), pp. 313-329.

that the amount of information purchased by decision-makers in choice situations depends on:

1. the prior probabilities of outcomes;
2. the payoffs of outcomes;
3. the cost and diagnositicy[6] of new information.

While the overall effect of these variables is in the direction a Bayesian model would predict, the magnitude of influence of these variables is less than normative. Moreover large individual differences exist in the information-seeking behavior of decision-makers.

Besides finding a qualitative correspondence, a number of researchers report a surprisingly high quantitative agreement between actual and normative amounts of information purchasing, when subjects' responses are considered as a group. Certain studies conclude that, in spite of large individual differences in responses between subjects, overall the mean or median decision-maker makes purchases very near the optimal amount of information.[7] The evidence of quantitative consistency is not universal: decision-makers, on average have been found to underbuy information,[8] and

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[6]Diagnosticity is the accuracy of information for a given cost.

[7]See for example: Ward Edwards and Paul Slovik, "Seeking Information to Reduce the Risk of Decisions," *American Journal of Psychology,* Vol. 68 (June, 1965), pp. 188-198. See also: Dean G. Pruitt, "Information Requirements in Making Decisions," *American Journal of Psychology,* Vol. 74 (September, 1961), pp. 433-439. See also: W. H. Starbuck and F. M. Bass, "An Experimental Study of Risk Taking and the Value of Information in a New Product Context," *Journal of Business* (1967), pp. 155-165. See also: Lisbeth S. Fried and Cameron R. Peterson, "Information Seeking: Optional Versus Fixed Stopping,"*Journal of Experimental Psychology,* Vol. 80 (1968), pp. 525-529.

[8]See for example: Gordon F. Pitz, Helen Reinhold, and E. Scott Geller, "Strategies of Information Seeking in Deferred Decision-Making," *Organizational Behavior and Human Performance,* Vol. 4 (1969), pp. 1-19. See also: C. Richard Chapman and Joseph Halpern, "Prior Probability Variation in an Information Purchase Task," *Psychonomic Science,* Vol. 18, No. 4 (1970), pp. 247-248.

in other studies, to overbuy information.[9] No explanation was provided for these apparently inconsistent conclusions.

The experimental findings demonstrate that decision-makers' information purchases are at least qualitatively consistent with the predictions of Bayesian analysis, and possibly quantitatively consistent when considered as a group. The evidence obtained from both the experimental research and the consumer search studies strongly suggests that a Bayesian normative model provides an excellent foundation for the derivation of a descriptive model of search expenditures.

2.4 DEVELOPMENT OF A NORMATIVE SEARCH EXPENDITURE MODEL

2.4.1 An Overview

The development of the Normative Decision Model for determining optional marketing research expenditures in a new product setting is outlined in this section. The Normative Decision Model relies on Bayesian methods to determine the optimal market assessment expenditure in a new product choice situation. The major determinants of the optimal amount of search fall into one of the following categories:[10]

1. variables describing the amounts at stake;
2. variables describing probabilities;
3. cost of search variables.

The Normative Decision Model differs from the usual form of the Bayesian

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[9]See for example: R. T. Kaplan and J. R. Newman, "Studies of Probabilistic Information Processing," *Transactions of Human Factors in Electronics* (1966), pp. 47-63. See also: Gordon F. Pitz, "Information Seeking When Available Information is Limited," *Journal of Experimental Psychology*, Vol. 75 (1962), pp. 25-34.

[10]See Section 2.2.

model in one important respect: it is in algebraic form to permit the study of directions of relationships. In contrast, most Bayesian models (including Bass' Marketing Research Expenditure Model)[11] are derived utilizing a concrete example, and hence are in arithmetic form.[12]

The relationships between the optimal amount of search and its determinants are reduced to a single algebraic statement. An analysis of the algebraic expression yields seven normative tenets, which prove useful in the development of the Behavioral Model.

2.4.2 A Decision Model of the Choice Situation

The Bayesian model for determining optimal levels of marketing research expenditures, proposed by Bass, provides the basis for the Normative Decision Model outlined in this section.[13] The decision task is to decide whether or not to introduce the new product, which of several alternative product introduction strategies should be selected, and how much market information should be purchased. In this section and the next, the Normative Decision Model is described conceptually, while the details of the mathematical derivations are presented in Appendix A.

New product decisions are characterized by a multi-stage process, each stage involving a number of alternatives. The decision process is also multidimensional: at each stage information may be sought and evaluated to provide answers to a number of questions, which include:

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[11]Bass, pp. 77-90.

[12]The relevant relationships in a Bayesian model could have been studied using simulation techniques. However the number of simulations required becomes very large in the case of more than two state, two action problems.

[13]Bass, pp. 77-90.

1. whether to continue developing the product, to introduce the product, or to abandon the project;
2. what product characteristics the product should have;
3. at what price the product should sell;
4. what quantity should be produced (and what size new plant should be built, if applicable);
5. what other elements of the marketing mix (such as distribution, advertising, and promotion) are most appropriate.

Since a high degree of interdependence exists between these decision dimensions, it is not realistic to consider these questions independently.[14] A single stage model is developed which addresses the first three questions: the introduce/cancel decision; the product characteristics choice; and the price selection. The model can be easily extended to consider the other dimensions of the choice situation.

A decision tree diagram outlines the alternatives faced in the choice model of the new product development process (figure 2.2). The decision – whether to seek market information or not – is represented by the first two branches on the decision tree. Following the "do not seek information" branch leads to a second decision: "which product introduction act is optimal?"

If A_i describes a single set of product characteristics, and P_i is a single price level, then each combination of A_i and P_i represents a product set, that is, one possible introductory act. If there are p possibilities for product characteristics and q price options, the decision-maker faces a total of $n = p \times q$ possible product sets or introductory acts.[15] Each of these price-product possibilities (i) may have various outcomes

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[14]The model proposed by Bass, is illustrated by a simple example, involving only the introduce/cancel decision, in response to several probabilistic sales levels.

[15]The number of choice alternatives may be extended to include decision

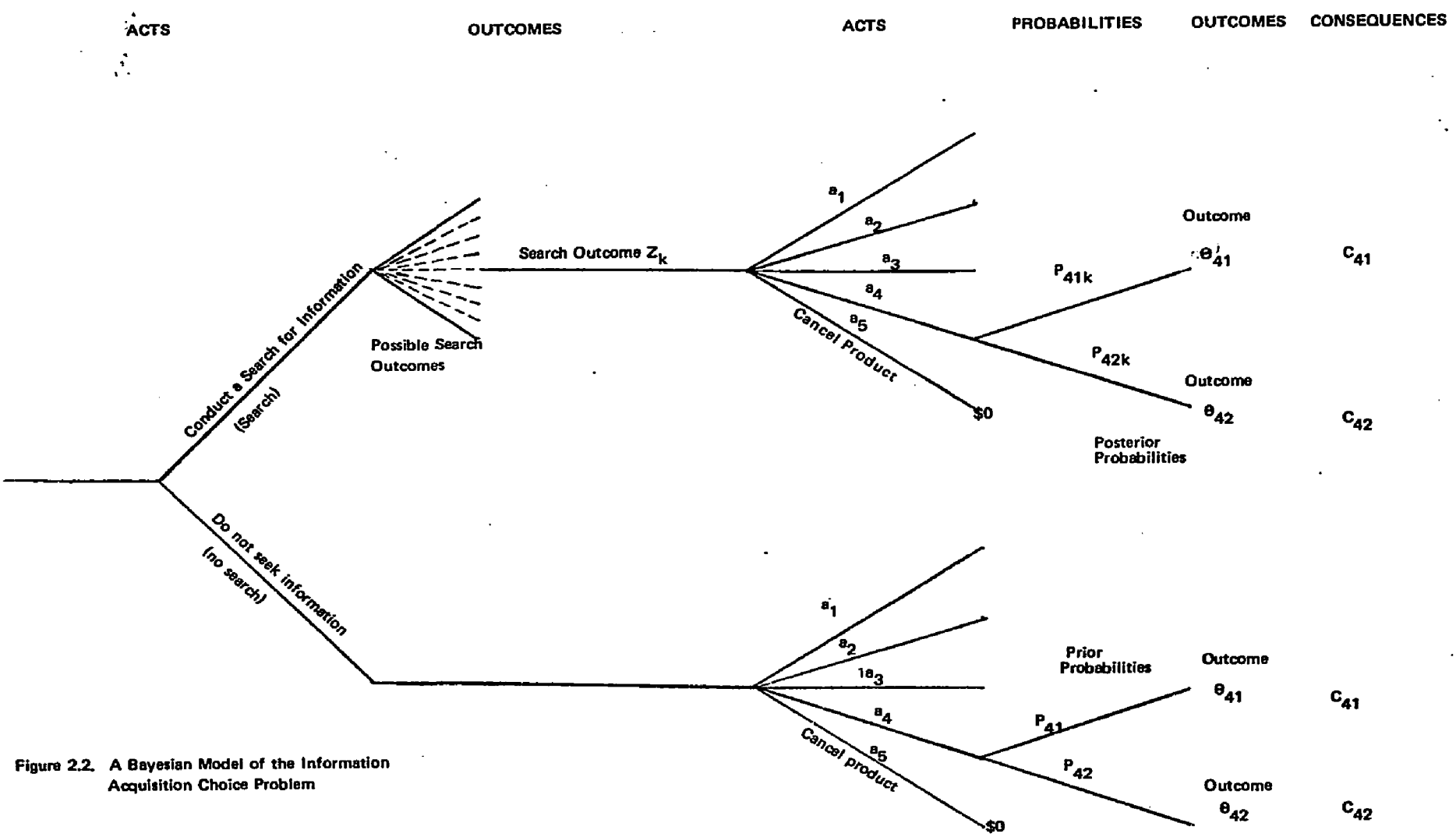

Figure 2.2. A Bayesian Model of the Information Acquisition Choice Problem

(θ_{ij}). Each outcome has a corresponding dollar consequence (C_{ij}).

For illustrative purposes, suppose p = 2 and q = 2, that is, two product characteristics possibilities and two price possibilities for a total of four price-product possibilities. These four possible product-price introduction acts are labelled a_1, a_2, a_3 and a_4 in figure 2.2. Another act is possible, a_5, the decision to cancel the product.

For simplicity, it is assumed that there are only two possible outcomes of each act, θ_{i1} and θ_{i2}, which represent a favorable outcome and an unfavorable outcome (success or failure). A dollar consequence (C_{i1} and C_{i2}) is determined for each outcome branch, as shown for act a_4 (C_{41} and C_{42} in figure 2.2). The outcome for act a_5, cancel the project, is \$0.

Before engaging in any search at all, the decision-maker has a subjective estimate regarding the chances that each act will result in one of the two outcomes. These subjective estimates are the initial probabilities he assigns to the various outcomes, given no additional information, and are called prior probabilities. In considering the introduction of the product-price combination denoted by act a_4, the prior probabilities of outcomes θ_{41} and θ_{42} are P_{41} and P_{42}, and are shown on the lower part of figure 2.2. If additional information could not be obtained, the decision-maker would choose the act whose expected value was maximum, where:

$$\text{Expected Value of act } i = \sum_{j=1,2} P_{ij} C_{ij} \qquad (2.1)$$

i = act number
j = outcome number

The appropriate act might very well be cancellation of the project, if \$0 is the maximum expected value of introduction acts.

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dimensions other than just price and product characteristics. For example, r introductory advertising and promotion levels might be available, for a total of p x q x r choice possibilities.

In a new product situation, it may be possible to acquire or purchase additional information to assist in the choice problem. The outcomes of the search are an indication of the probabilities of success or failure for the different price-product combinations. The possible outcomes of the search are denoted in figure 2.2 by a fan, while only one search outcome, Z_k, is considered for illustrative purposes.

Bayes' Theorem provides a rigorous technique for revising prior probabilities in the light of additional information to obtain posterior probabilities. These are the probabilities assigned to outcomes of acts, given additional information, in this case, the outcome of the search (P_{41k} and P_{42k} in figure 2.2). For each search outcome, the optimal act is determined again using the maximum expected value criterion.

The expected value of search information (EVSI) can now be determined.[16] Combining the expected value of the best act for each search outcome with the probabilities of various search outcomes occurring, permits the calculation of the expected value with search, EVS. Bayes' Theorem yields the probabilities that the various search outcomes will occur. The expected value of search information (EVSI) is the difference between the expected value of outcomes with and without search: the difference between the expected values of the Search and No Search branches of Figure 2.2. It does not include the cost of search:

Expected Value of Search Information (EVSI)	=	Expected Value with Search (EVS)	−	Expected Value with No Search (EVNS)	(2.2)

2.4.3 Determination of Optimal Search Expenditure

The Bayesian decision model outlined above permits the calculation of the

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[16] In Bayesian analysis, EVSI is frequently referred to as the Expected Value of Sample Information.

expected value of search information for a single search level. When the value of information is compared to the cost of search for various search levels, the optimum search level can be determined.

A number of different levels of search activities are possible, each with its own degree of accuracy and cost. Traditionally, search level has been defined so that it is linear with cost (such as in terms of sample size, figure 2.3). In the Normative Decision Model developed for this study, search level is defined in terms of accuracy. Search accuracy is "the probability that the search portrays the world the way the world really is". Accuracy can therefore range from zero to unity.[17] Figure 2.4 shows the cost of search and value of search information (EVSI) plotted against search accuracy. At high accuracies (perfect information), search cost becomes very high.

The optimal search level or search accuracy occurs when the marginal value and marginal cost of search are equal, that is, when the marginal expected value of search information (MEVI) equals the marginal cost of search (MCS). In figures 2.3 and 2.4, the optimum level or accuracy of search is S* and the cost of this optimal search is CS*.

An algebraic expression for the marginal expected value of search information (MEVI) is derived from the Bayesian model developed above. Two specific cases of this general model are examined in detail in Appendix A: a single alternative choice model, and an "n" alternatives choice model. The relationship between the MEVI and its determinants is reduced to a simple equation, having the form:

$$MEVI = nPR + (1-P)F \tag{2.3}$$

where:

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[17]For amore detailed discussion of search accuracy, see Appendix A.

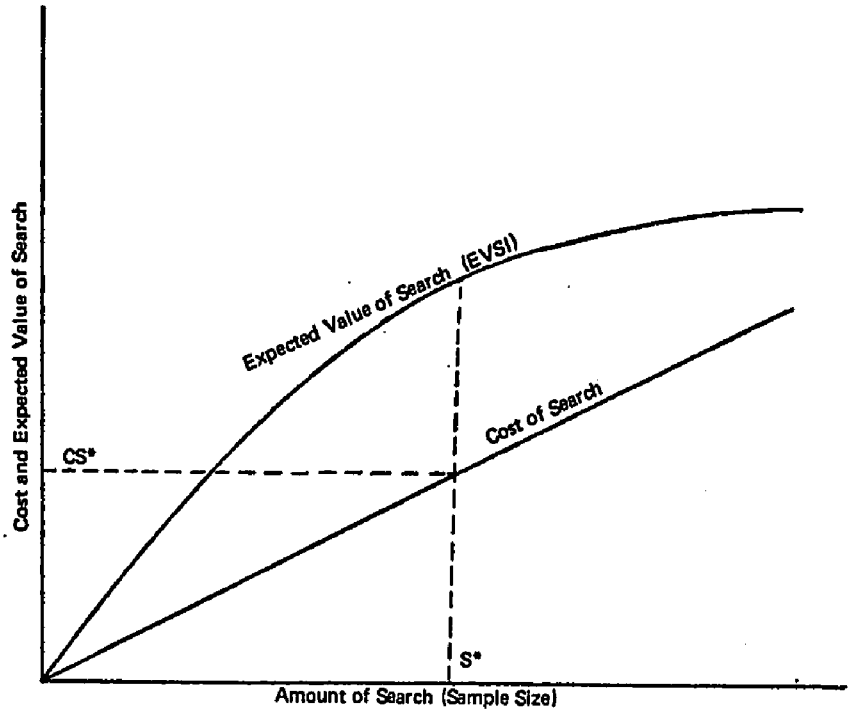

Figure 2.3. Relationship Between Amount of Search (Sample Size) and Cost and Value of Information.

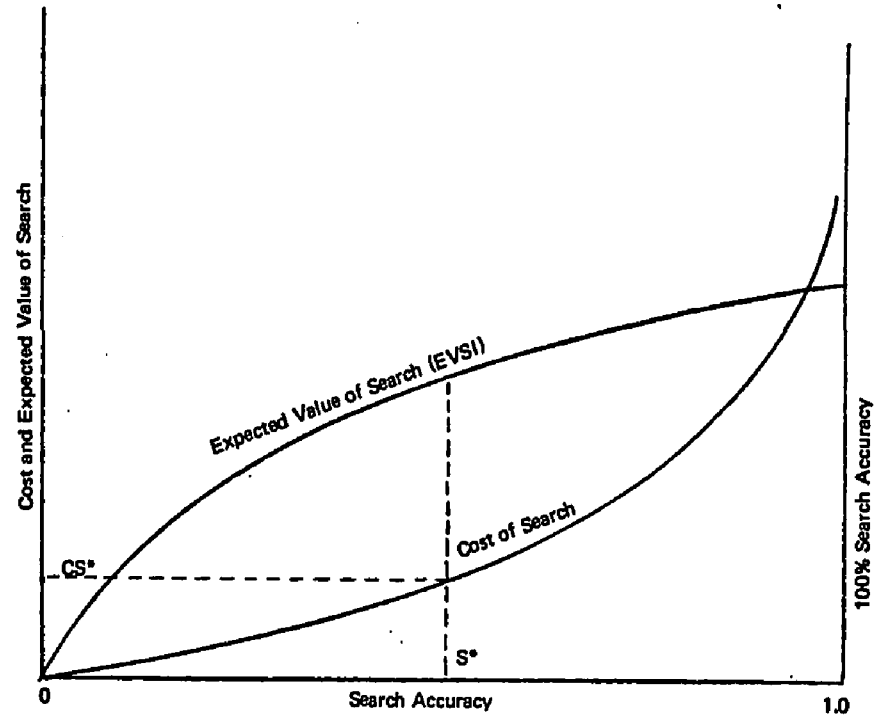

Figure 2.4. Relationship Between Search Accuracy and Cost and Value of Information.

P = the level of prior probabilities of success.

n = the number of alternatives considered.

R = the anticipated rewards or payoffs if the product is a sucess.

F = the possible cost of failure.

The level of prior probabilities of success is a composite measure of the probabilities of the considered acts leading to success, given no benefit of additional information. For convenience, the model assumes equal probabilities of success for the n alternatives considered, and calls this probability the prior level, P.

The number of alternatives is the number of acts in the decision problem leading to outcomes which are mutually exclusive: if act 1 is successful, then act 2 must result in failure. The act of cancellation is not included in the total, so that in figure 2.2, the number of alternatives is four (n = 4).

When P and n are considered together, they represent a measure of the distribution of prior probabilities, and hence the uncertainty of the choice situation. A broad, shallow distribution (low P, high n) represents a highly uncertain situation.

2.3.4 Normative Conclusions on Search Expenditures

An optimal search expression now can be derived, which relates the optimal cost of search to its determinants: probabilities, values and cost. The MEVI expression (equation 2.3) is equated to the marginal cost of search in Appendix A to yield the desired normative relationship:

$$CS^* = \frac{MEVI}{r} = \frac{nPR + (1-P)F}{r} \qquad (2.4)$$

where CS* = the optimal search cost.

r = per cent marginal cost of search.[18]

The development of this relationship yields a number of normative tenets, which are summarized in Table 2.1. These seven normative tenets, which provide the link between assessment expenditures and values, probabilities and costs, are utilized in the development of the Behavioral Model in the next chapter, and are subsequently referred to as Tenet 1 through Tenet 7.

2.5 SUMMARY

This chapter has outlined the major descriptive findings of studies into information purchasing. Overall, decision-makers' information purchasing behavior is qualitatively consistent with a normative model, but quantitatively and individually, deviations occur. The Bayesian model was proposed as a useful guide to the development of a descriptive model, and for this purpose, the Normative Decision Model of the market assessment decision in a new product setting was developed. Four major constructs – value of market information, cost of market information, amounts at stake, and uncertainties and probabilities – were suggested by both the Normative Decision Model and descriptive studies. These constructs, as well as the seven normative tenets which summarize the relationships in the Normative Decision Model, form the foundation for the development of the Behavioral Model in the next chapter.

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[18]The per cent marginal cost of search is the ratio of the per cent increase in search cost required to yield a given improvement in the search accuracy.

TABLE 2.1

SUMMARY OF NORMATIVE TENETS

TENET	THE OPTIMAL COST OF SEARCH INCREASES WITH:	CONSTRUCT
1	higher anticipated payoffs of success.	Amounts at Stake
2	higher possible costs of failure.	
3	more choice alternatives with correspondingly lower prior levels.	Uncertainties and Probabilities
4	higher uncertainties.	
5	more alternatives together with higher prior levels.	
6	lower per cent marginal costs of search.	Cost of Market Information
7	larger populations of information sources.	

CHAPTER III

DEVELOPMENT OF THE BEHAVIORAL MODEL

3.1 INTRODUCTION TO THE MODEL

The focal topic of this research concerns the amount of market assessment which is undertaken during the development of new industrial products. This chapter develops the hypothesized descriptive model of this research, the Behavioral Model. The Behavioral Model postulates that the amount of market assessment conducted in a new product project is related to variables which characterize the new product situation faced by the firm.

The development of the Behavioral Model assumes that managers' information buying behavior is qualitatively consistent with the predictions of a normative model. The Normative Decision Model developed in Chapter II, which was proposed as a useful base for the derivation of a descriptive model, suggests the main constructs and relationships of the Behavioral Model for this research. Four main constructs – value of information, cost of information, probabilities and uncertainties, and amounts at stake – constitute the framework of the Behavioral Model, linking the new product situation to the amount of assessment undertaken (see figure 3.1). The amount of assessment depends on the perceived value of information and on the perceived cost of obtaining it. Value of information is related to the probabilities and uncertainties of the situation and the amounts at stake.[1] In this chapter, a number of new product

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[1]Basing the Behavioral Model on a normative analysis does not imply that the neurological processes of the human mind approach those prescribed by a norma-

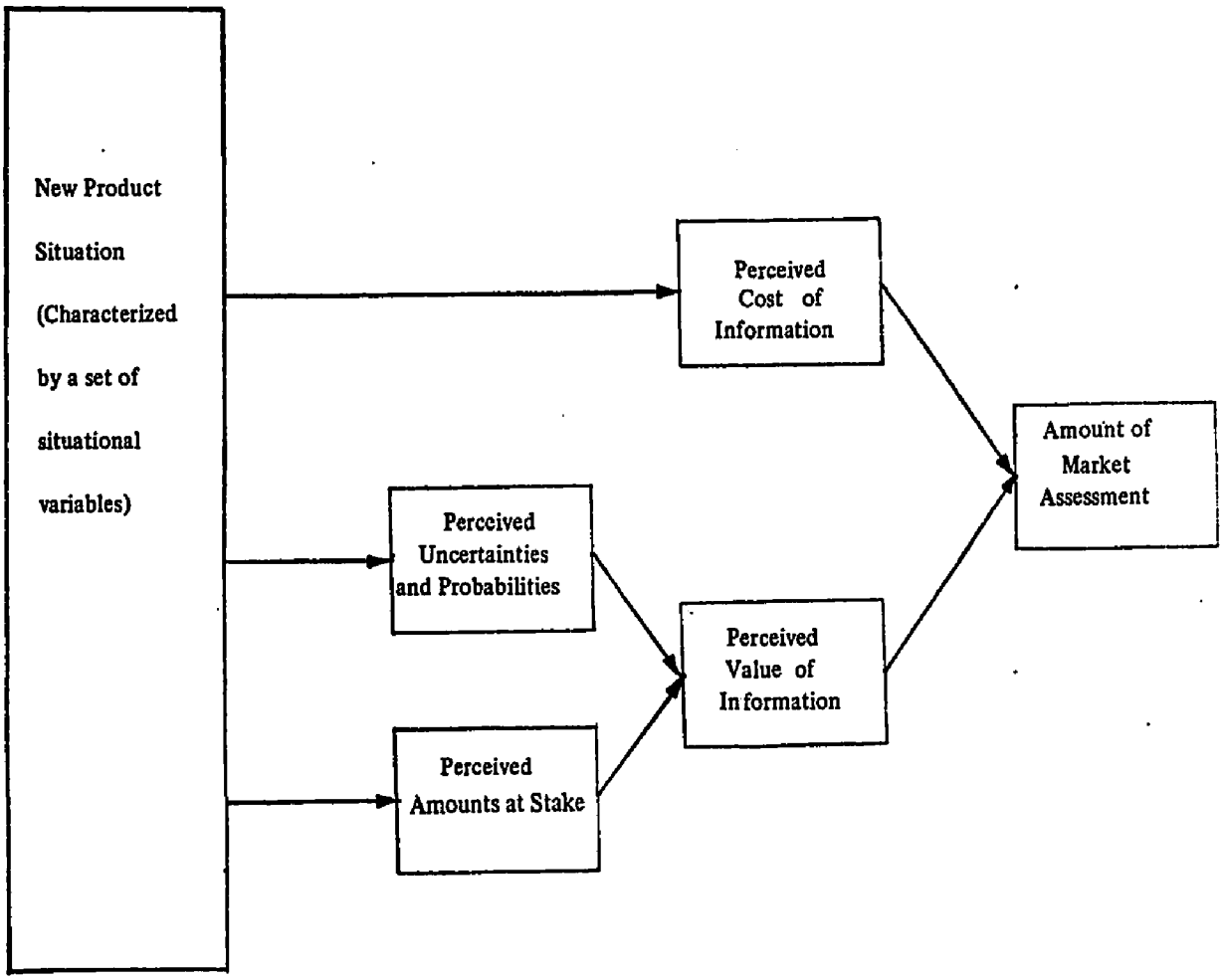

Figure 3.1. A Simplified Version of the Behavioral Model.

situational variables are identified which likely affect managers' explicit or implicit perceptions of the amounts at stake, uncertainties and probabilities, and costs of market information, and therefore can be directly linked to the amount of market assessment undertaken.

3.2 PROPOSED DETERMINANTS OF MARKET ASSESSMENT EXPENDITURES

3.2.1 Introduction

The central core of Section 3.2 is a series of postulates about the overall responses of managers to variables which characterize a new product situation. This section focusses on how these new product situational variables – which are anchored in the reality of the situation and are familiar to most managers[2] – probably affect managers' perceptions of:

- the amounts at stake in the project;
- the probabilities and uncertainties of the situation (including the number of alternatives faced);[3]
- the cost of search versus improvements in search accuracy (per cent

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tive model. While managers do not necessarily consciously determine probabilities, values and costs, the Behavioral Model suggests that they behave as though they do. A well known example which parallels this approach is the use of utility curves to explain or simulate choices made by decision-makers.

[2]A survey of management opinion which focussed on market appraisal for new industrial products suggested many of the new products situational variables of this research, namely: anticipated payoffs, absolute and relative cost of failure, market newness, market stability, product newness to the market and to the firm, degree of competition, purchase importance, payback period, number and types of customers, customer accessibility, and time urgency of development. See: National Industrial Conference Board, *Appraising the Market for New Industrial Products,* Studies in Business Policy, No. 123 (New York: NICB, 1967), pp. 5-10.

[3]The phrase "probabilities and uncertainties" is used to denote the values of probabilities and the number of options faced – that is, the total probability distribution. This distribution is also a measure of the uncertainties of the situation.

marginal cost of search).[4]

Secondly, these relationships between the new product situational variables and values, probabilities, and costs, together with the normative tenets from the previous chapter (Table 2.1, Chapter II), suggest the effect that each new product situational variable likely has on the amount of market assessment conducted.[5] The manager's perception of the new product situation prior to undertaking market assessment is postulated to affect the amount of assessment he undertakes. Therefore the new product situational variables are defined as perceived by the manager, at the beginning of the new product development process. A summary of the postulated relationships is provided in Table 3.1 at the end of Section 3.2.

3.2.2 Amounts at Stake

The amounts at stake – the consequences of possible outcomes – probably influence the amount of market assessment a manager undertakes in a new product venture.[6] For simplicity, the Behavioral Model assumes that only two outcomes of a venture are possible: success and failure. The consequences in the event of success are the anticipated payoffs, and in the event of failure are the possible costs of failure.

The simple dichotomy between success and failure may not be an accurate

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[4]The percent marginal cost of search may be difficult to guage in various new product settings. A measure of this value is obtained by the answer to the question: "what improvement in search accuracy results from doubling the search cost?" Unless the effects of the new product situation on per cent marginal cost of search are obvious, a low effect is assumed.

[5]A standard format has been used where possible to describe the expected effects of each new product situational variable. Moreover for the sake of style and brevity, probabilistic phrases, such as "can be expected to lead to" are replaced with determinate statements, such as "leads to", even though these statements are postulates rather than scientific laws.

[6]Assumes managers' behavior is qualitatively consistent with Tenets 1 and 2 of the Normative Decision Model, Chapter II, Table 2.1.

presentation of the way in which managers perceive a new product situation. More outcomes might have been considered by providing a continuum from "great success" to "disastrous failure" and noting the consequences in theevent of each possible outcome, but the result is a much more complex model, whose utility to the present research is greatly reduced. Moreover, Mansfield and Brandenburg report that managers seem to simplify a new product setting and act as though there were only two commercial outcomes to a project, "success" and "failure".[7]

1. Anticipated Payoffs:

Increases in the manager's perception of the anticipated payoffs – expected sales or profits – is hypothesized to result in more new product market assessment. A manager may perceive the dollar payoffs of success in several ways.[8] Therefore, three alternate payoff functions are proposed for the Behavioral Model, and include:

(a) anticipated annual product sales;
(b) anticipated annual product profits;
(c) anticipated product profits discounted over the life of the product.

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[7]Edwin Mansfield and Richard Brandenburg, "The Allocation, Characteristics, and Outcomes of the Firm's Research and Development Portfolio: A Case Study," *Journal of Business* (October, 1966), p. 448.

[8]Ideally the payoffs from a new product venture should be determined from a present value analysis: the payoffs equal the present value of future profits, discounted at the marginal cost of capital, less investment and development costs. See: Morris J. Gottlieb and Irving Roshwald, "The 'Present Value' Concept in Evaluating New Products," in *New Ideas for Successful Marketing*, ed. J. S. Wright and J. J. Godstucker (Chicago: American Marketing Association, 1966), pp. 387-400. However it is likely that managers resort to simplified strategies in initially assessing the payoffs from a new product venture, particularly in veiw of the evidence that more sophisticated techniques have not gained widespread acceptance even in larg corporations, and for pre-commercialization financial analyses. See Stanley J. Shapiro and Danny Aronchik, "The New Product Evaluation Process: Theory and Canadian Practice," (working paper, McGill University, 1972).

Increases in the manger's perception of the annual product sales, or annual product profits, or discounted profits, are expected to increase the amount of market assessment conducted (see Tenet 1).

2. Possible Cost of Failure

Increases in the manager's perception of the possible cost of failure – the consequence of unfavorable outcomes – is hypothesized to increase the amount of market assessment conducted during the new product venture (see Tenet 2). The costs of failure generally include the development costs, non-recoverable investment, and introduction expenses.

3. Relative Cost of Failure

The cost of failure of the project relative to potential costs of failure of other product ventures undertaken by the firm is expected to influence the manager's perception of the amounts at stake. Increases in the relative cost of failure is hypothesized to result in more market assessment conducted during a new product venture (see Tenet 2). Although two firms may face the same actual cost of failure in product projects, the utility of these potential losses may differ.[9] One method of introducing the utility concept is to construct a preference or utility curve for each firm involved. The methodological problems of this route are evident.[10] A more viable approach

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[9]This concept appears to have been outlined first by Daniel Bernoulli (1700-1792). According to Bernoulli, the dollar that might be precious to a pauper would be nearly worthless to a millionaire. This concept of utility has been more recently revived by Von Neumann and Morgenstern; see: J. Von Neumann and O. Morgenstern, *Theory of Games and Economic Behavior* (Princeton U. Press, 2nd edition, 1947). For a historical review of utility, see: L. J. Savage, "Historical and Critical Comments on Utility," reprinted in *Decision Making*, ed. Ward Edwards and Amos Tversky (Baltimore: Penguin Books, 1967), pp. 96-110.

[10]See for example: F. Mosteller and P. Nogee, "An Experimental Measurement of Utility," reprinted in *Decision Making*, pp. 124-169.

involves measuring the cost of failure of the particular project relative to other projects the firm undertakes. The magnitude of previous gambles reflects the firm's "conservatism" or "extravagance",[11] and therefore the relative cost of failure is a measure of the disutility of the new product's possible losses.

3.2.3 Probabilities and Uncertainties

The values and distribution of the probabilities of success and failure probably influence the amount of market assessment undertaken in a new product venture.[12] This section focusses on those new product situational variables which are linked to the probabilities and uncertainties of the new product situation, and suggest their resulting effect on market assessment expenditures.

1. Market Newness to the Company

More market assessment is hypothesized to result when the new product is sold to new markets and unfamiliar customers to the firm.[13] If the new product market lies outside the body of recognized company knowledge, the manager is operating in a state of partial ignorance, and hence with a higher degree of uncertainty. In completely new markets, the manager is confronted with a greater number of choice alternatives, since he has no "prior feel" for rejecting alternatives outright. Facing a large number of uncertain alternatives, he probably believes that each of the many

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[11]For a more complete discussion of conservative and extravagant utility curves, see: Mosteller and Nogee, pp. 124-169.

[12]Assumes managers' behavior is qualitatively consistent with Tenets 3, 4 and 5 of the Normative Decision Model, Chapter II, Table 2.1.

[13]Market newness was suggested as a critical variable in organizing for new product development in: S. C. Johnson and C. Jones, "How to Organize for New Products," *Harvard Business Review* (May, June, 1957), p. 52.

alternatives has a low chance of success. Market newness effects on the cost of search have no obvious influence on the amount of search undertaken, since doubling the assessment efforts in both familiar and new markets yields similar increases in search accuracies.

Therefore, faced with increasing market newness, the manager considers more alternatives, and perceives greater market uncertainties and a lower level of prior probabilities, and thus conducts more market assessment during the new product venture (see Tenets 3 and 4).

2. Market Stability

More market assessment is hypothesized to result when the new product market is rapidly changing. A product market where customers' needs and preferences are highly unstable creates high market uncertainties for the new product manager. The manager considers more alternatives in his new product decisions and views the chances of new product success, without current market information to be lower. While a stable market may be easier to assess, the per cent marginal costs of search are perceived by managers to be equivalent – doubling the assessment should yield similar improvements in search accuracy in either type of market.

Faced with a rapidly changing or unstable market, the manager considers more alternatives, and perceives greater market uncertainties, and therefore conducts more market assessment during the new product venture (see Tenets 3 and 4).

3. Newness of the Product to the Market

When the new product is very new to the market-place, more market assessment is hypothesized to result during the development phase. A product which resembles existing products on the market creates fewer uncertainties for the manager

– the product concept has already been tested, desirable and undesirable features are more obvious, and pricing and volume figures may be known. However, in developing a totally new product to the market, the manager, operating in a state of partial ignorance, considers more decision alternatives, and sees the chances of success of each alternative to be lower.

Product newness also has a pronounced effect on the perceived cost of information. This relationship is discussed in Section 3.2.4.

Faced with a totally new product to the market, the manager considers more alternatives, and perceives greater market uncertainties, and a lower prior level, and as a result, tends to conduct more market assessment during the new product venture (see Tenets 3 and 4).

4. Degree of Competition in the New Product Market

The expectation that competitive resistance and reactions will be met in the new product market likely influences the manager's perception of the uncertainties and probabilities of the situation. Less market assessment is hypothesized to be conducted when the new product market is highly competitve. Increasing competition decreases the manager's assessment of the chances of success prior to search. Given the case of extreme competition, the manager is unwilling to undertake extensive assessment if he believes that regardless of his product strategy, his chances of a successful venture are low.

The possibility of competitive reaction increases some of the uncertainties associated with the new product situation. However, acquiring the type of information to minimize competitive uncertainties is typically difficult, illegal or virtually impossible, and hence does not represent a major proportion of market assessment activities.[14] On

[14]In previous discussions, when managers were questioned about the type of

the other hand, the number of alternatives a manager faces in a highly competitive situation are frequently limited, and the manager may actually feel more certain about which courses of action are required. The nature of the uncertainties arising from competitiveness in the new product market tend to have a mixed and therefore minor effect on the amount of assessment undertaken.

Faced with a high degree of competition in the new product market, the manager considers fewer alternatives, and perceives lower chances of success, and in spite of mixed feelings regarding uncertainties, he tends to conduct less market assessment (see Tenet 4).

5. Technical Newness to the Company

More market assessment is hypothesized to result when the new product is also technically very new to the firm.[15] If the new product represents a minor modification of an existing product, then the market response is anticipated by the manager with a reasonably high degree of confidence. However, products which are a departure from existing company products produce greater market uncertainties. In addition, faced with a new type of product to his firm, the manager considers a greater number of alternatives, and, prior to search, places a lower success probability on each alternative.

While the market assessment activities for a technically new product may be more expensive than for a modified product, the per cent marginal cost – the accuracy improvement by doubling the assessment effort in either situation – is perceived by the

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assessment they undertook to reduce competitive uncertainties, virtually all indicated they could not or did not undertake this type of assessment to any great extent.

[15]Johnson and Jones suggest the variable, Technical Newness, as a criterion in organizing for new product development. See: Johnson and Jones, p. 52.

manager to be about the same, and therefore cost of search has no obvious effect on assessment expenditures.

Faced with a technically new product to his company, the manager considers more alternatives and perceives greater market uncertainties and a lower prior level, and generally conducts more market assessment during the new product venture (see Tenets 3 and 4).

6. Product Complexity

The technical complexity of the product – whether the product is a complex one with many possible technical variations, or a technically simple product – likely affects the manager's perception of the uncertainties and probabilities of the situation. More market assessment is hypothesized to result when the new product is a technically complex one.[16] A new product situation involving a technically complex product presents a greater number of new product possibilities along technical dimensions, requiring the new product manager to consider a greater number of decision alternatives. With more alternatives to consider, the prior probability that any one alternative will lead to success is lower, and the uncertainties of the situation are magnified. The effect that product complexity has on the cost of information is discussed in Section 3.2.4.

Faced with a more complex product, the manager considers more alternatives, and perceives greater market uncertainties and a lower prior level, and as a result, tends to conduct more market assessment (see Tenets 3 and 4).

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[16]Lawyer describes product complexity as a key factor in industrial marketing. See: K. Lawyer, "Product Characteristics as a Factor in Marketing" (unpublished paper, Case Western Reserve University, 1967).

7. Purchase Task Newness to the Buyer

More market assessment is hypothesized to result during the development of a product which represents a new purchase task to the buyer. The extensiveness of the buyer's search and evaluation, the information required, and the number of alternate suppliers considered were reported to increase in the case of new purchase task versus straight rebuy situations.[17] A more extensive buyer evaluation lessens the chances that a product, designed and marketed on the basis of little market information, will be a successful venture. Moreover an extensive buyer evaluation increases the number of important dimensions the new product manager considers during the development of the product. Finally, if the buyer is unwilling to evaluate a new product (straight re-buy situation), the success prospects of the new product are much lower,[18] and the certainty of failure is higher.

A product's purchase task newness has a pronounced effect on the cost of search. This relationship is discussed in Section 3.2.4.

In developing a new product whose purchase task is newer, the new product manager considers a greater number of alternatives, and sees a lower prior level and greater uncertainties. As a result, he tends to conduct more market assessment (see Tenets 3 and 4).

8. The Importance of the Purchase to the Buyer

If the new product represents an important purchase, then the new product

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[17]P. J. Robinson, C. S. Faris and Y. Wind, *Industrial Buying and Creative Marketing* (Boston: Allyn and Bacon, 1967), pp. 28-38.

[18]Robinson, Faris and Wind note that the prospects of a current non-supplier becoming a regular source are doubtful in the case of a straight rebuy situation, but improve with increasing purchase task newness. See: Robinson, Faris and Wind, pp. 28-38.

manager is hypothesized to conduct more market assessment during the development phase. More important purchases are reported to involve more specialized buyers, and more extensive and critical buyer evaluation.[19] Therefore increasing importance of the purchase has the same effect on amount of assessment as the purchase task newness.[20] Relationships between purchase importance and the cost of search are outlined in Section 3.2.4.

9. Payback Period

New product ventures with a longer payback period are hypothesized to involved more market assessment. If profits must be discounted many years into the future to justify the venture, the manager sees greater uncertainties, particularly on those estimates with a greater time horizon – the greater the time horizon, the greater the errors in estimates.[21] The possibility of errors increases the manager's apprehension about the profitability of the project, and facing greater uncertainties, he conducts more market assessment (see Tenet 4).

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[19]The main dimensions of purchase importance include:
- buyer investment in the purchase;
- size of order;
- time length of commitment;
- effect on buyer's profitability.

See: L. Fisher, *Industrial Marketing* (London: Business Books, 1969), p. 24. To avoid confusion, Fisher's nomenclature (Commercial Uncertainty to the Buyer) has been altered to Purchase Importance.

[20]The manager considers more alternatives, and perceives a lower prior level and greater uncertainties, and therefore conducts more market assessment. See item 7 above.

[21]An analysis of new product sales forecasts indicates that estimates generally become less accurate with increasing time horizon; see: Donald S. Tull, "The Relationship of Actual and Predicted Sales and Profits in New-Product Introductions," *Journal of Business*, Vol. 40, N. 3 (July, 1967), p. 233.

3.2.4 Cost of Market Information

The Behavioral Model suggests that managers make search expenditure decisions as though they were considering the cost of search, and more specifically, as though they were responding to some quantity analogous to the per cent marginal cost of search. In simpler terms, the per cent marginal cost of search can be approximated by the response to the question: "what improvement in search accuracy can be expected if the assessment effort were to be doubled?" In this section, those new product situational variables which probably influence the manager's perception of the cost of search, and their resulting effect on the extent of assessment undertaken, are discussed.

1. Number of Potential Customers

When the market for a new product is limited to only a few potential customers, less market assessment is hypothesized to result during the development of the product. A small number of potential customers essentially limits the number of possible information sources (see Tenet 7).

2. Number of Market Segments

When the market for a new product consists of many market segments, less market assessment is hypothesized to result during the venture. The presence of more than one market segment tends to increase the manager's perception of the number of information sources required for a given search accuracy. However, because not all segments are likely of equal importance, as less vital segments are researched, the returns to search accuracy diminish rapidly. The manager perceives an increase in the per cent marginal cost of search in the case of many segments, and therefore undertakes less market assessment (see Tenet 6).

3. Customer Accessibility

If potential customers are readily accessible (for purposes of acquiring market information), more market assessment is hypothesized to result during the development of a new product. When customers are geographically inaccessible, or if they prove unwilling to cooperate, the new product manager perceives a higher per cent marginal costs of search, and therefore conducts less market assessment (see Tenet 6).

4. Time Urgency of Development

When development time is at a premium, less market assessment is hypothesized to result during the development phase. Fear of competitive moves, the need for secrecy, or the transient nature of the market may render delays in product development very costly. Faced with a great urgency for product introduction, the manager perceives a high per cent marginal cost of search, and tends to conduct less assessment (see Tenet 6).

5. Purchase Importance

The importance of the purchase to the potential customer can be logically expected to increase the manager's perception of the value of information,[22] but at the same time, has an effect on his perceived cost of information.

Increasing purchase importance was reported to result in greater cooperation between customer and product developer,[23] and therefore has a similar perceived

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[22]See Section 3.2.3.

[23]NICB, *Appraising the Market.*

effect on search costs as increasing customer accessibility. Therefore, in developing a product whose purchase is important, the manager perceives a higher value of information, and a lower per cent marginal cost of information, and as a result, tends to conduct more market assessment during the new product venture (see Tenet 6).

6. Purchase Task Newness, Product Newness and Product Complexity

The newness and complexity of the product and purchase task can be logically expected to increase both the value and the cost of market information and hence to have mixed effects on the amount of assessment undertaken.[24] A complex product, a product that is new to the market, or a product whose purchase task is new, lies outside the body of knowledge possessed by the typical customer. Obtaining information on desirable product characteristics, pricing considerations, potential volume, and the buying and adoption process, becomes increasingly difficult as the search proceeds – customers are simply unable to provide this type of information with any degree of reliability, and accuracy returns to search cost diminish rapidly.[25] Therefore the manager perceives the per cent marginal cost of search to be higher in the case of a new and complex product or purchase task. However, it is expected that the magnitudes of the uncertainties in such situations will cause the manager to seek the needed information, and that the value of search effects outweigh the cost of search effects.[26]

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[24]See Section 3.2.3.

[25]The difficult or impossible nature of conducting market research for totally new products with new purchase tasks was summed up by Edwin Herbert Land of Polaroid Corp.: "Each new product our firm develops is . . . *sui generis* – in a class by itself. That distinction makes conventional market research a waste of time and money," in *Time Magazine* (June 26, 1972), p. 45.

[26]It appeared inconceivable that a manager would commit substantial resources to a highly uncertain new product venture, and fail to attempt to reduce these uncertainties by conducting the needed market assessment.

Thus purchase task newness, product newness and product complexity are hypothesized to be positively related to assessment expenditures.

Besides researching potential customers, two other sources may provide the manager with market information. These are:

1. secondary sources (such as published data);
2. internal information (stored from previous experience).

The use of both secondary sources and internal information has been indirectly considered in the Behavioral Model. Many of the variables which affect the availability and cost of information from customers have a similar effect on the cost of information from secondary sources. For example, increasing purchase task newness, product complexity, product newness, and time urgency can all be expected to decrease the availability or relevance of data from secondary sources, and hence increase the per cent marginal cost of information from these sources. Similarly, the various newness dimensions of the new product situation – product newness, technical newness and market newness – determine the utility of internal information in reducing market uncertainties.

3.2.5 Summary of the Behavioral Model

The Behavioral Model is a hypothesized model which postulates that the amount of market assessment is a function of variables which describe the new product situation faced by the firm. These new product situational variables describe the amounts at stake, the uncertainties and probabilities of the situation, and the costs of market information. The new product situational variables are defined as perceived by the manager near the beginning of the new product development process. A normative analysis suggested the directions of relationships between the amount of assessment conducted

and the new product situational variables. The resulting Behavioral Model is shown in schematic form in figure 3.2, while Table 3.1 summarizes the proposed relationships.

Two alternate mathematical forms are proposed to describe the relationships between the amount of market assessment conducted and the new product situational variables. These include:

1. a linear additive model;
2. a multiplicative exponential model.

The linear additive model assumes that the new product situational variables are related to the amount of assessment in a linear and additive fashion:

$$MA = \alpha_0 + \alpha_1 X_1 + \ldots\ldots\ldots + \alpha_n X_n \qquad (3.1)$$

where MA = amount of market assessment.

α_i = coefficients.

X_i = new product situational variables.

The multiplicative exponential model assumes that the new product situational variables are related to the amount of assessment in a multiplicative fashion:

$$MA = \alpha_0 (X_1)^{\alpha 1} \cdot (X_2)^{\alpha 2} \ldots\ldots\ldots \cdot (X_n)^{\alpha n} \qquad (3.2)$$

where X_i = new product situational variables.

α_i = exponential coefficients.

The value of the exponential coefficients indicates how quickly MA increases or decreases with changes in each new product situational variable.

The multiplicative exponential model is expected to describe the decision rules

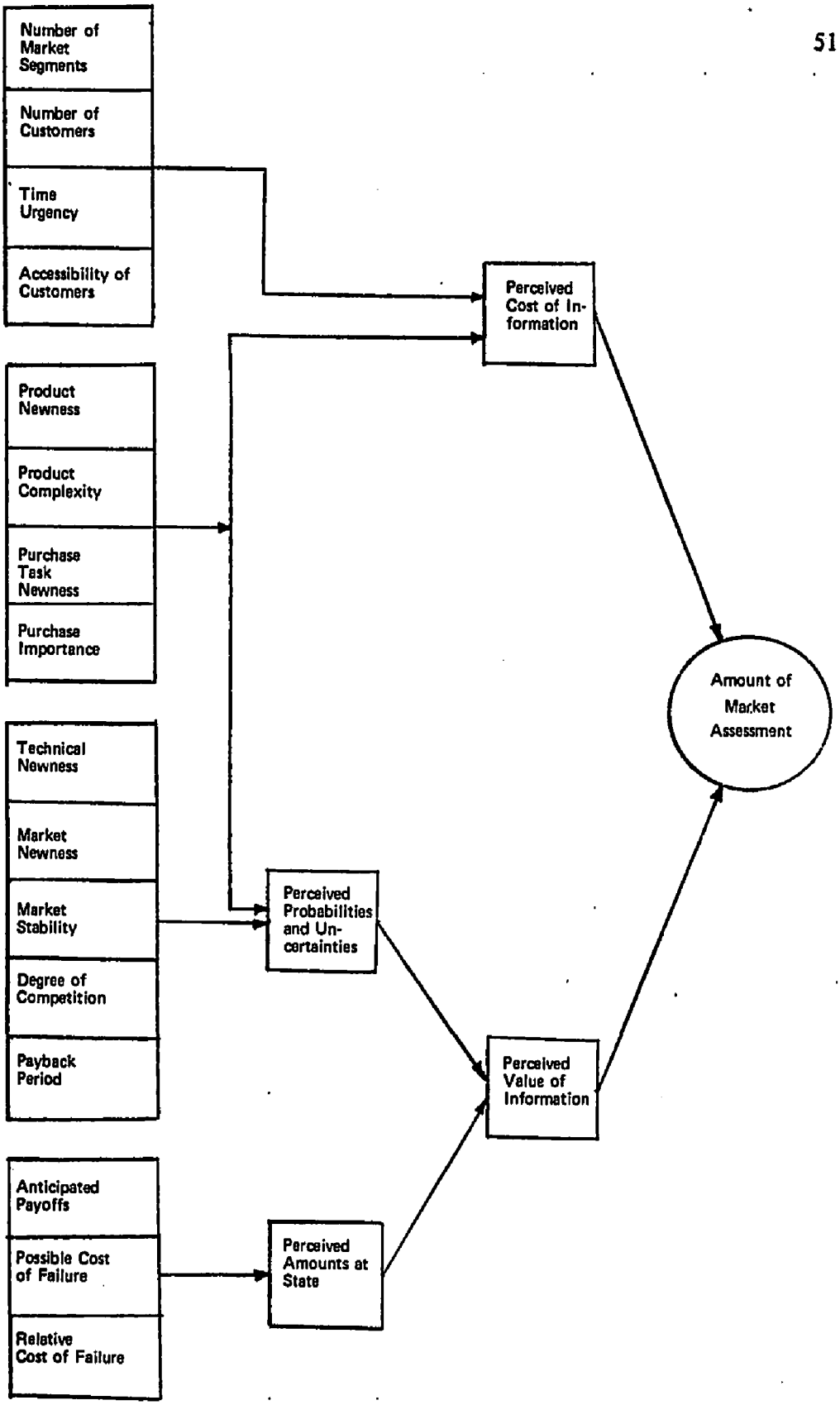

Figure 3.2. Outline of the Proposed Behavioral Model

TABLE 3.1

SUMMARY OF THE EFFECTS OF NEW PRODUCT SITUATIONAL VARIABLES ON AMOUNT OF MARKET ASSESSMENT (MA)

VARIABLES DESCRIBING THE AMOUNTS AT STAKE		
Variable Symbol	Variable Name	Effect on Market Assessment
R	Anticipated Payoffs	↑
F	Possible Cost of Failure	↑
RF	Relative Cost of Failure	↑

VARIABLES DESCRIBING UNCERTAINTIES AND PROBABILITIES					
Symbol	Variable Name	Effect on			
		No. of Alternatives	Prior Level	Uncert-ainty	Market Assessmt.
MN	Market Newness to the Company	↑	↓	↑	↑
SM	Market Stability	↓	↑	↓	↓
PN	Product Newness to the Market	↑	↓	↑	↑
DC	Degree of Competition	↓	↓	—	↓
TN	Technical Newness to the Company	↑	↓	↑	↑
PC	Product Complexity	↑	↓	↑	↑
PTN	Purchase Task Newness	↑	↓	↑	↑
PI	Purchase Importance	↑	↓	↑	↑
PP	Payback Period	—	—	↑	↑

VARIABLES DESCRIBING COST OF INFORMATION		
Symbol	Variable Name	Effect on Market Assessment
NC	Number of Potential Customers	↑
MS	Number of Market Segments	↓
CA	Customer Accessibility	↑
TU	Time Urgency of Development	↓
PI**	Purchase Importance	↑
PTN*	Purchase Task Newness	↓
PN*	Product Newness for the Market	↓
PC*	Product Complexity	↓

*denotes variable has several effects on amt. of assessment, which are expected to oppose each other.
**denotes variable has several effects on amount of assessment, which are expected to complement each other.
↑ indicates positive effect.
↓ indicates negative effect.

of managers more appropriately than the linear additive form. In the first place, multiplicative effects are intuitively more important than additive effects: for example high uncertainties likely increase the assessment expenditure by a greater amount in high consequence projects than in low consequence projects. Secondly, the Normative Decision Model developed in Appendix A, relating the optimal cost of search to probabilities, values and costs, although having a mixed additive and multiplicative form, can be approximated by a simple multiplicative exponential expression.

3.3 LIMITATIONS OF THE BEHAVIORAL MODEL

The Behavioral Model developed for this research contains a number of simplifying assumptions and therefore is not a true representation of reality. However the purpose of the model is not to perfectly describe actual information purchasing behavior, but simply to generate testable hypotheses and to suggest a set of relevent variables for measurement.

The model therefore only approximates reality, and deviations from the model are expected to result from:

1. individual differences: the model focusses on the response of a typical manager, and does not consider individual differences – perceptual biases and decision rules – between firms and managers.[27]
2. non-normative behavior: the model assumes a quasi-normative approach to information seeking, and does not consider the limitations of the

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[27]Individual differences in information purchasing behavior were reported in a number of studies. See Section 2.3.2, Chapter II. Cyert and March theorize that organizational search is biased by the training, experience and goals of the participants of the organization. See: Richard M. Cyert and James G. March, *A Behavioral Theory of the Firm*, (Englewood Cliffs, N.J.: Prentice-Hall, 1963), chap. 6.

human neurological system,[28] the simple-minded nature of search,[29] and the closely sequenced search-evaluation process.[30]

3. dynamic information seeking: the model is based on a static representation of the choice situation, and model variables are defined at a fixed point in time, while actual search behavior is a dynamic process.[31]

These assumptions limit the model's ability to describe exactly the information acquisition behavior of managers.

3.4 SUMMARY

This chapter has outlined the development of the hypothesized descriptive model of the research, the Behavioral Model. The model postulates that the amount of market assessment conducted is a function of a set of variables which characterize a new product situation.

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[28]Serial processing, small short term memory, infinite long term memory, fast retrieval but slow storage. See: Herbert A. Simon and Allen Newell, "Human Problem Solving: The State of the Theory in 1970," *American Psychologist*, Vol. 26 (1971) pp. 145-159.

[29]Cyert and March, chap. 6. Also, Emory and Niland note that managers, in their search activities, tend to think in terms of the immediate, known and controllable: C. William Emory and Powell Niland, *Management Decision Making* (Boston: Houghton Mifflin, 1968), pp. 69-73.

[30]Emory and Niland, pp. 69-73. This process is analogous to "satisficing". See: James G. March and Herbert A. Simon, *Organizations* (New York: John Wiley and Sons, 1958), pp. 140-141.

[31]The static nature of the Behavioral Model does not invalidate its use as a descriptive tool – a dynamic model can be thought of as a series of static models, requiring the same input variables, and generating qualitatively similar relationships.

The Behavioral Model assumes that managers' information purchasing behavior is qualitatively consistent with a normative analysis and, therefore the model is based on the Normative Decision Model developed in the previous chapter. A set of new product situational variables, which describe a new product project, were linked to managers' likely perceptions of the amounts at stake, the uncertainties and probabilities of the situation, and the cost of market information. The hypothesized relationships between the situational variables and the amount of market assessment were suggested by first studying the relationships of the Normative Decision Model.

The Behavioral Model was presented in schematic form in figure 3.2, and linear additive and multiplicative exponential mathematical representations were suggested. A discussion of the limitations reveals that the model is not a true representation of reality, and that it is not expected to completely describe information purchases by managers.

CHAPTER IV

BEHAVIORAL STUDIES AS PRESCRIPTIVE GUIDES

4.1 INTRODUCTION

One of the concerns of this research is the development of a preliminary prescriptive guide to assist managers in determinating appropriate market assessment expenditures during the development of new industrial products. In this chapter, two possible routes towards the derivation of such a guide are explored. The first route utilizes an empirically derived descriptive model of past management decisions, the Average Manager Model. The second approach focusses on the market assessment expenditures associated with "better practice" projects. The rationale and validity of both routes are examined in this chapter.

4.2 THE AVERAGE MANAGER MODEL

4.2.1 Empirically Derived Normative Guides

The use of an empirically derived relationship, which describes the past decision behavior of managers, has been proposed as a guide to management decision-making.[1] In the field of business research, such models have been called Management Coefficients Models,[2] while psychologists have recently termed the approach "boot-

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[1]Edward H. Bowman, "Consistency and Optimality in Managerial Decision Making," *Management Science* (January, 1963).

[2]Bowman.

strapping".[3]

A Management Coefficients Model is simply an empirically derived regression equation which relates the past decisions of a manager to a set of variables which influenced his decision.[4] Both the form of the decision rule and the variables in the relationship are selected in advance on the basis of a normative analysis, while the coefficients of the model are empirically determined. The resulting model is a representation of the manager's own decision rule.

The use of a Management Coeffficients Model as a guide to future decisions is based on the premise that by averaging out a manager's inconsistencies, his intuitive decision rules would be capable of near optimal performance.[5] The approach assumes that management's decisions suffer more from inconsistencies than from biases, that managers are sensitive to key decision criteria, and that their decisions tend to be within the range of preferred alternatives.[6] They are imperfect information processors, however, and their decisions are erratic. The premise, is that while humans may be used to generate decision rules, they should afterward be removed from the system and be replaced by their own decision rules.[7]

Management determined decision rules, when used to simulate past decisions, achieved results which were better than actual performance, and near to optimal

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[3]Paul Slovik and Sarah Lichtenstein, "Comparison of Bayesian and Regression Approaches to the Study of Information Processing in Judgement," *Organizational Behavior and Human Performance,* Vol. 6 (1971), pp. 649-744.

[4]Bowman.

[5]Bowman.

[6]Bowman.

[7]L. W. Dudycha and J. C. Naylor, "Characteristics of the Human Inference Process in Complex Choice Behavior Situations," *Organizational Behavior and Human Performance,* Vol. 1 (1966), pp. 110-128.

performance.[8] Gordon showed that economic performance could be improved if management was more consistent in applying a set of implicit decision rules, by using a Management Coefficients Model.[9] Slovik and Lichtenstein review a number of experimental studies where regression models based on subjects' past decisions do a remarkably good job of decision-making, in fact, better than the subjects' judgements themselves.[10]

4.2.2 The Average Manager Model as a Prescriptive Guide

An empirical model describing the decisions of managers in terms of rationally selected predictor variables frequently generates decisions closer to the optimum than actual performance. Therefore an empirical model based on the Behavioral Model of the present research may provide useful inputs to managerial decisions on market assessment expenditures. The Behavioral Model, derived in Chapter III, relates management decisions to a set of hypothesized predictor variables which were selected on the basis of a normative analysis. If empirical data from actual management decisions are used to test the hypothesized model equations, the resulting best fit empirical expression would meet some of the criteria of a Management Coefficients Model.

The nature of the population of management decisions represents the major difference between the descriptive model of this research and the traditional approach. Management Coefficients Models typically are derived from populations of decisions

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[8]Bowman.

[9]John R. M. Gordon, "A Multi Model Analysis of Aggregate Scheduling Decisions," (unpublished Ph.D. dissertation, Alfred P. Sloan School of Management, 1966), pp. 50-52; pp. 148-160.

[10]Slovik and Lichtenstein, pp. 649-744.

made by the same individual or the same organization.[11] The present research focusses on decisions made by many managers employed by different firms. The Behavioral Model, with coefficients empirically derived, is more accurately defined as a model of the decision behavior of the average manager or management in the sample studied – an Average Manager Model. In spite of this redefinition of the population of decisions, the Average Manager Model – essentially the Behavioral Model with empirically derived coefficients – should prove useful as a prescriptive guide to managerial decision.

4.3 ASSESSMENT EXPENDITURES IN BETTER PRACTICE PROJECTS

4.3.1 An Overview

The Average Manager Model approach to deriving a normative guide which was outlined in the previous section may be deficient because of large and consistent biases in management decisions. In the case of marketing research expenditures, the available evidence suggests that bias might exist – that too little new product market assessment is undertaken.[12] Alternate methods of deriving a prescriptive guide should therefore consider the possibility of bias in assessment expenditures.

One alternative route to the development of a guide for management decisions on market assessment is the study of new product projects in which the amount of assessment conducted is very likely to approach the optimal assessment expenditure. The intent of this section is to outline criteria to identify projects where the amount of assessment undertaken probably approaches the true optimal amount (if this amount

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[11]Bowman. See also: Gordon, pp. 188-203.

[12]Blair Little, Robert G. Cooper and Roger A. More, "Putting the Market into Technology to Get Technology into the Market," *Business Quarterly* (Summer, 1972), pp. 62-69. See also: Chapter I, Section 1.1.2.

could be determined) for the particular new product situation faced. These projects can be called better practice projects, while all other projects are referred to as poorer practice projects. A comparison of assessment expenditures in average projects and better practice projects would provide a useful input to a prescriptive guide for managers.

4.3.2 Identification of Better Practice Projects

Ideally, better practice projects should be selected by directly comparing the actual amounts of assessment conducted with the amount of assessment that should have been conducted. However the available normative standards are inadequate for determining optimal assessment expenditures, and there exists no operational method for suggesting how much assessment should have been conducted.[13] Therefore other criteria must be used which will help identify those projects where normative amounts of assessment were likely conducted.

In general, experienced and trained decision-makers are more likely to make better decisions. In addition, the outcomes or results of decisions probably reflect the quality of the decisions. Therefore, two criteria which could be useful in identifying better management decisions indirectly are:

1. the training and experience of the decision-makers; and
2. the ultimate results of the decisions.

In the case of new product market assessment, it appears logical that projects with normative amounts of market assessment are more likelyh to be well-managed projects which were carried out by firms with more experienced and trained new product personnel. Therefore variables which purport to measure the training and experience

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[13]See Chapter I, Section 1.1.3.

of new product personnel in general and personnel involved in the market assessment function in particular, may be useful identifiers of better practice projects – that is, projects more likely to have normative amounts of market assessment. Similarly, projects with normative amounts of assessment, because they are likely to be well-managed projects, probably are projects where better ultimate results were achieved. Thus, variables which purport to guage the ultimate results of new product management in general, and the results of good market assessment decisions in particular, may also be useful identifiers of better practice projects (see figure 4.1).

4.3.3 Criteria of Better Practice Projects

In this section, four criteria to identify better practice projects are proposed. The first two criteria are suggested as measures of the training and experience of new product personnel in general, and market assessment personnel specifically. These criteria are:

1. very large firms; and
2. firms which employ full-time market assessors.

The other two criteria focus on the results of better decision-making. One variable specifically guages the results of conducting normative amounts of market assessment, while the other reflects the results and hence the quality of the management of the new product development process in a firm. These criteria are:

1. projects where errors in market estimates were satisfactorily reduced; and
2. firms with highly successful new product programs.

The reasons for selecting each variable as a criterion of better practice projects are outlined below:

1. Very Large Firms

Very large firms – for example, those with annual sales of $100 million or

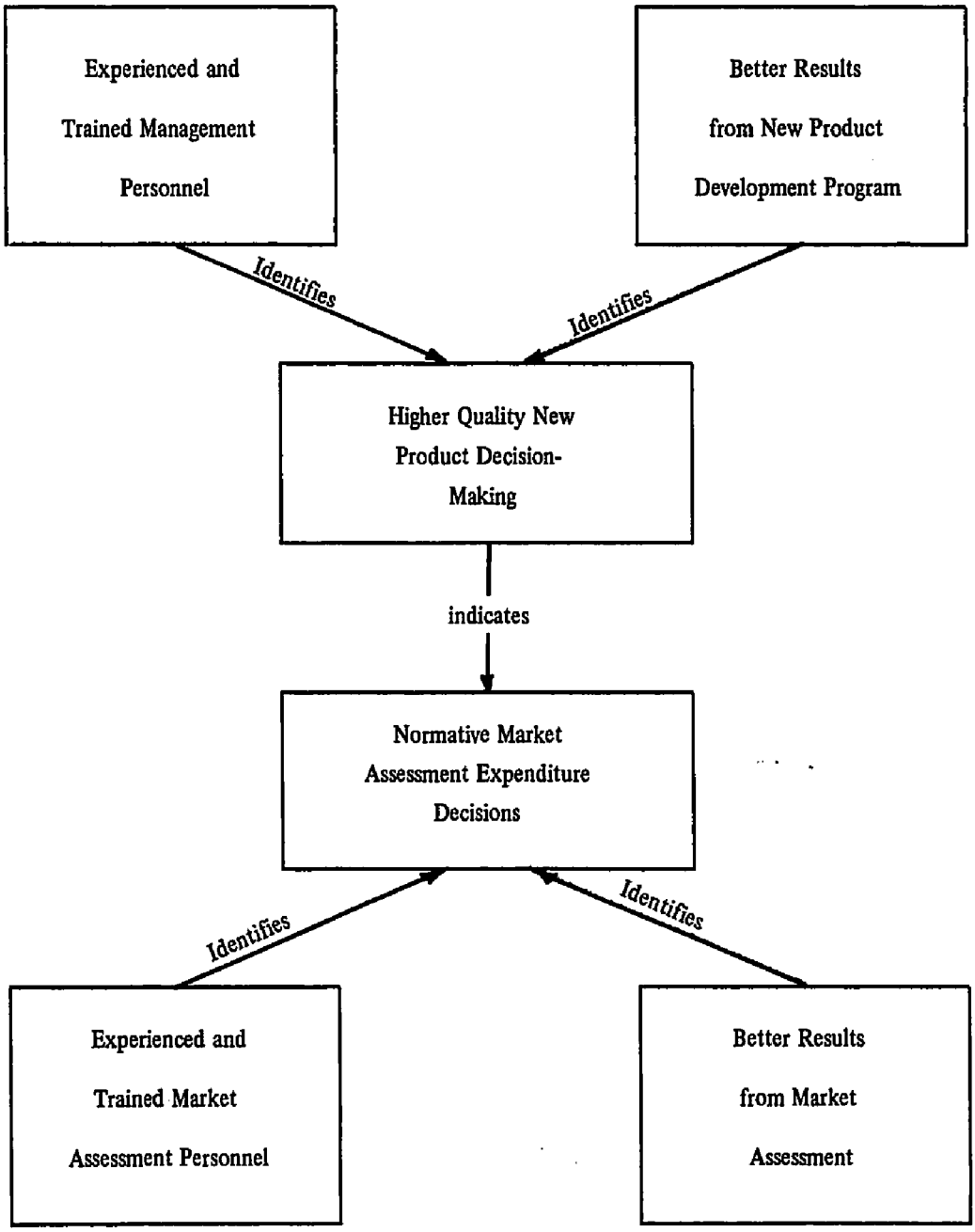

Figure 4.1 Criteria for Identifying Better Market Assessment Expenditure Decisions.

more – are likely to conduct more normative amounts of assessment in their new product ventures. In the first place, a large firm probably has a deeper and broader experience in new product development, and the firm's new product personnel and their management skills should have benefitted from this experience. Secondly, the depth and diversity of management personnel are likely to be greater in larger firms. Finally, very large companies are more likely to utilize more formal methods in the analysis and planning of a new product project. Because certain resources, characteristics and practices normally typical of large corporations should in many cases lead to better new product project management (and hence are more likely to be associated with normative assessment practices), company size is a useful criterion to identify better practice projects.

2. Firms With Market Assessment Personnel

Firms with at least one employee whose full time task is market assessment, are expected to conduct more appropriate amounts of assessment in their new product ventures. Conversely, the firm that does not employ a full time assessor is likely to undertake too little market assessment in a project. This firm lacks the staff to undertake the market study, and also lacks personnel with the special skills and formal training frequently required to study industrial markets. As a result, the firm faces a major barrier to conducting the appropriate amount of assessment and therefore tends to avoid market research, or at best, to do only a nominal amount.[14] On the other hand, the firm employing one or more full time assessors has a higher probability of conducting the appropriate amount of assessment.

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[14]Managers tend to avoid the unknown and unfamiliar in their search activities. See: C. William Emory and Powell Niland, *Management Decision Making* (Boston: Houghton Mifflin, 1968), pp. 69-73.

3. Projects Where Market Errors Were Reduced

One measure of the benefits of conducting market assessment is the degree to which managers are able to reduce errors in market estimates during the development of the product. In many new product ventures, managers may initially make incorrect estimates about certain market factors, including estimates about desired product characteristics, product pricing and sales volume. The purpose of market assessment is to reduce market uncertainties and to enable managers to make better estimates of important market factors such as those outlined above. A logical deduction is that a project where managers failed to reduce errors in market estimates during the development phase is probably one where too little market assessment was undertaken; conversely when the appropriate amount of assessment is undertaken, then the errors in market estimates are likely to be substantially reduced.

The degree to which managers are able to reduce errors in estimates about desired product characteristics, selling price and sales volume is an indicator of whether the appropriate amount of assessment was undertaken, and is therefore a useful criterion to identify better practice projects.

4. Firms With Successful New Product Programs

The success rating of a firm's new product program may be a useful measure of better practice projects. Successful new product programs are likely the result of effective new product project management, and therefore should be associated with normative market assessment expenditures.

A manager's subjective rating is proposed in this research as a measure of the performance of a firm's new product development program. While various objective measures might be proposed (such as number of new products introduced,

per cent sales by new products, corporate growth, and corporate profitability), each of these measures is heavily influenced by variables over which the firm has little control. For example, the characteristics of the industry – growth rate, innovativeness, maturity, competitiveness – likely influence each objective measure of new product performance. However, in providing a subjective rating, the manager is expected to take into account the special set of circumstances his firm faces.

4.3.4 Better Practice Projects as a Prescriptive Guide

Four criteria to identify better practice projects – that is, projects characterized by normative amounts of assessment – have been proposed in the preceding section. The utility of this approach toward the development of a prescriptive guide depends on two assumptions:

1. that these criteria are valid identifiers of projects where more normative ammounts of assessment are undertaken;

2. that the assessment expenditures in those projects identified by the four criteria are indeed different from the assessment expenditures in other projects, for equivalent new product situations.[15]

The logic underlying the selection of each criterion of better practice appears to support the first assumption. There is no absolute assurance that the proposed criteria are valid identifiers of better practice projects, although they do appear reasonable.

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[15]The qualification that new product projects should have equivalent situations in order to permit meaningful comparisons, suggests, for example, that it is unreasonable to draw conclusions from a comparison of assessment expenditures in very large versus very small projects.

The second assumption is investigated by restating the relationships between these four criteria of better practice and the market assessment expenditures in the form of testable hypotheses. The typical project is probably characterized by far too little assessment. Therefore, for equivalent new product situations, more market assessment is postulated to be conducted in projects:

- undertaken in very large firms;
- undertaken in forms employing at least one market assessor.
- where initial errors in market estimates were substantially reduced.
- undertaken in firms with extremely successful new product programs.

If these measures are accepted as useful criteria of better practice, and if the postulates are supported by empirical evidence, then the projects identified by these criteria should prove useful in the development of a prescriptive guide.

4.4 SUMMARY

Two approaches to deriving prescriptive guides to assist managers in their market assessment expenditure decisions were outlined in this chapter. The first approach is based on the premise that managers' decisions are more inconsistent than biased, and that managers should be replaced by their own decision rules. The Behavioral Model of this research, with empirically derived coefficients – the Average Manager Model – was therefore proposed as a useful guide for management.

The second prescriptive method considers the possibility of bias in management decision-making, and focusses on better practice projects – that is, projects where normative amounts of assessment were likely undertaken. Four criteria for the identification of better practice projects were outlined. The magnitude of the difference in market assessment expenditures in these better practice projects compared

to all the projects and to poorer practice projects should contribute to the development of a prescriptive guide.

CHAPTER V

STATEMENT OF HYPOTHESES

5.1 INTRODUCTION

In Chapter V, the main hypotheses of the research, which were developed in the two previous chapters, are summarized and restated in a more rigorous fashion. One of the objectives of the research is to investigate the relationships between the amount of market assessment which firms undertake during the development of new industrial products and those factors which influence this amount. The first set of hypotheses, H_1, focusses on these relationships.

A second objective is the development of prescriptive managerial guides, specifically by studying the market assessment expenditures in better practice projects.

5.2 HYPOTHESIS SET H_1

The Behavioral Model, developed in Chapter III, proposes that the amount of market assessment conducted in a new product venture is related to variables which characterize the new product situation. These variables describe the amounts at stake, the uncertainties and probabilities of the situation, and the cost of market information. The proposed relationships between the amount of market assessment and the new product situational variables constitute the first set of hypotheses, H_1, and are presented in Table 5.1.

Mathematical representations of the Behavioral Model relationships were also postulated. These include both linear and multiplicative expressions relating amount of

TABLE 5.1

HYPOTHESIS SET H_1

The amount of market assessment conducted during the development of a new industrial product is related to:			
Hypothesis Number	Variable Symbol	Variable Name	Hypothesized Effect
		Amounts at Stake	
$H_{1.1}$	R	Anticipate Payoffs if product is successful*	positive
$H_{1.2}$	F	Possible Cost of Failure	positive
$H_{1.3}$	RF	Relative Cost of Failure	positive
		Uncertainties and Probabilities	
$H_{1.4}$	MN	Newness of Product Market to the Firm	positive
$H_{1.5}$	SM	Stability of Market for the Product	negative
$H_{1.6}$	PN	Newness of Product to the Market	positive
$H_{1.7}$	DC	Degree of Competition in the Product Market	negative
$H_{1.8}$	TN	Technical Newness of Product to the Firm	positive
$H_{1.9}$	PC	Product Complexity	positive
$H_{1.10}$	PTN	Purchase Task Newness	positive
$H_{1.11}$	PI	Importance of the Purchase	positive
$H_{1.12}$	PP	Payback Period	positive
		Cost of Market Information	
$H_{1.13}$	NC	Number of Potential Customers for the Product	positive
$H_{1.14}$	MS	Number of Market Segments	negative
$H_{1.15}$	CA	Customer Accessibility (for Market Information)	positive
$H_{1.16}$	TU	Time Urgency of Development	negative

The hypothesized form of these relationships is:

$$MA = \alpha_o (X_1)^{\alpha_1} (X_2)^{\alpha_2} \ldots\ldots\ldots\ldots (X_n)^{\alpha_n}$$

where MA = amount of market assessment conducted.

α_i = coefficients

Xi = new product situational variables

*Three payoff functions were proposed: anticipated annual product sales (S); anticipated annual profits (PR); and discounted profits (DPR).

assessment to the hypothesized determinants. The multiplicative form is expected to best describe these relationships (see Table 5.1).

5.3 HYPOTHESIS SET H_2

In Chapter IV, better practice projects were hypothesized to be characterized by higher levels of market assessment when the new product situations faced are equivalent. Four criteria to identify better practice projects were outlined. The second set of hypotheses, H_2, postulates a positive relationship between these four criteria of better practice and the amount of market assessment, for similar new product situations. These hypotheses are presented in Table 5.2.

TABLE 5.2

HYPOTHESIS SET H_2

For equivalent new product situations, the amount of market assessment conducted during the development of new industrial products is greater in product ventures:	
HYPOTHESIS NUMBER	BETTER PRACTICE CRITERIA
$H_{2.1}$	undertaken in very large firms
$H_{2.2}$	undertaken in firms employing at least one full time market assessor.
$H_{2.3}$	where initial errors in market estimates were substantially reduced.
$H_{2.4}$	undertaken in firms with highly successful new product development programs

CHAPTER VI

METHODOLOGY OF THE RESEARCH

6.1 INTRODUCTION

The previous chapter presented the two sets of hypotheses of the research, which concern the amount of market assessment undertaken in industrial new product ventures. The present chapter reports the research methodology used to test these hypotheses. The data collection phase is first described, while the obstacles faced in data collection are reviewed to help justify the appropriateness of the measurement methods. The data analysis techniques employed and the rationale for selecting these particular analytical methods are also outlined.

6.2 DATA COLLECTION

A large number of successful new product projects undertaken by firms were studied in order to provide the data required to test the hypotheses. The sample of firms and projects as well as the measures of the variables for the present research existed in the form of a data bank. This data bank was developed over a period of several years as part of an on-going study into the development of industrial new products in Canada.[1] The data utilized in the present research were obtained during personal interviews with managers as well as in short-answer mailed questionnaires.

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[1]An outline of this on-going study is given in: Blair Little, Robert G. Cooper and Roger A. More, "The Assessment of Markets for the Development of New Industrial Products in Canada," (working paper No. 62, University of Western Ontario, 1971).

Tables 6.1 and 6.2 outline the variables which were utilized to test the two sets of hypotheses. Operational definitions of all variables and a description of the sample of firms are provided in Appendix B.

The sample of firms was selected from a population of Canadian industrial goods manufacturers located in Ontario and Quebec which were known to be active in new product development.[2] While the sample included firms of all sizes and from many industries, it excluded certain industries (such as industrial services and natural resource firms, whose new product development activities were thought to be limited), and also tended to be weighted towards larger firms to reflect the number of projects associated with larger firms versus smaller firms.

Personal interviews were conducted during the summer of 1971 in 152 firms with the manager or managers most involved with the firm's new product development activities from a marketing viewpoint. Interviews lasted from two to four hours and were based on a lengthy printed questionnaire. Data were sought at two levels – information about the company in general, and also data on a specific successful new product project. The manager selected a successful new product project with which he was quite familiar.[3] The project was also typical to his firm and had been undertaken during the last five years. A number of questions were posed to characterize the new product situation, and to describe the development and market assessment activities undertaken during the project. (See Appendix B).

Successful new product projects were studied instead of failure projects for several reasons. First, since failure projects are often cancelled prior to commercialization, expenditures on market assessment are very dependent on the particular phase at

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[2]The main source of the population of firms was: Canada, Department of Industry, Trade and Commerce, *Directory of Scientific Research and Development Establishments in Canada* (1969). Other private lists of firms supplemented the population.

[3]Later during the interview, the manager was required to rate the success of the venture on a 5 point Likert scale.

TABLE 6.1

MEASURES OF VARIABLES FOR HYPOTHESIS SET H_1

Item Number in Appendix B	Variable Symbol	Variable Name	Units	Method of Measurement
1.1	MA	Amount of Market Assessment Conducted	manhours	interview
3.1	S	Anticipated product Annual Sales	$000	interview
1.2	F	Possible Cost of Failure	$000	interview
3.1	PR	Anticipated product Annual Profits	$000	interview
3.1	DPR	Anticipated product Profits, discounted	$000	interview
2.1	RF	Relative Cost of Failure	Likert*	mailback
2.2	MN	Market Newness to the Company	Likert*	mailback
2.3	SM	Market Stability	Likert*	mailback
2.4	PN	Product Newness to the market	Likert*	mailback
2.5	DC	Degree of Competition	Likert*	mailback
2.6	TN	Technical Newness to the company	Likert*	mailback
2.7	PC	Product Complexity	Likert*	mailback
2.8	PTN	Purchase Task Newness	Likert*	mailback
	PI	Purchase Importance (four measures)**		
3.2	PI–1	- selling price	$	interview
2.9	PI–2	- order size	$	mailback
2.9	PI–3	- time effect on customers	years	mailback
2.9	PI–4	- effect on customer profit	Likert*	mailback
3.3	PP	Payback Period	years	interview
1.3	NC	Number of Potential Customers	number	interview
2.10	MS	Number of Market Segments	Likert*	mailback
	CA	Customer Accessibility (two measures)**		
2.11	CA–1	- customer willingness to provide information	Likert*	mailback
2.11	CA–2	- customer geographic accessibility	Likert*	mailback
3.4	TU	Time Urgency of development	Likert*	interview

*measured on a 5 point Likert scale.
**Two variables, Purchase Importance and Customer Accessibility, were measured in more than one way.

TABLE 6.2

MEASURES OF VARIABLES FOR HYPOTHESIS SET H_2

Item Number in Appendix B	Variable Name	Units	Method of Measurement
1.4	Annual Sales of the firm	$000	interview
1.5	Number of full time market assessors employed by the firm	number	interview
1.6	Errors in estimates of product characteristics (both initial errors and errors at commercialization)	Likert*	interview
1.6	Errors in estimates of selling price (both initial errors and errors at commercialization)	percent	interview
1.6	Errors in estimates of sales volume (both errors initially and errors at commercialization)	percent	interview
3.5	Managerial rating of the success of the firm's new product development program	Likert*	interview

*measured on a five point Likert scale.

which the project was terminated, making comparisons of projects difficult. Secondly, preliminary discussions with managers revealed that the amounts of market assessment, even in the best of product projects, were expected to be small and difficult to measure, and therefore measurement of assessment expenditures in failure projects would prove even more difficult. Finally, a major concern of the research is the development of a prescriptive guide to indicate how much market assessment firms ought to undertake. Successful projects are therefore more appropriate examples on which to base the prescriptive guide than failure products.

Additional data were sought from the same firms and managers during the fall of 1972. Communications had been maintained with the managers previously visited, and where a manager had changed jobs his replacement was contacted. Before visiting the firms a second time, a short-answer questionnaire was mailed to the managers, which was designed to seek more information on the product already discussed. The manager was requested to complete this "mail-back" questionnaire, and to return it in the addressed and stamped enveloped provided (see Appendix B).

Next the managers were personally interviewed. These interviews lasted from two to three hours, and again were based on a detailed printed questionnaire. More information describing the firm and the new product venture previously discussed was obtained. (See Appendix B.)

The sample of projects ultimately analysed in this research totals 118 successful new product ventures, a subset of the original 152 firms and projects. Three firms had ceased operations and another five firms no longer wished to participate in the study. Other projects were deleted because of substantial missing data: managers could not or would not provide certain interview data, or did not return the mail-back questionnaire. A description of the resulting sample of firms by industry and company size is presented in Table B.1, Appendix B. Neither the sample of firms nor the

selection of projects within firms is truly random, but the absence of a complete listing of characteristics of the population of firms and projects precluded an estimate of sample bias. However no major biases were obvious in the sample, and it is reasonable to assume that the research results may be generalized with caution to other successful Canadian industrial new product ventures.

6.3 LIMITATIONS OF THE DATA

The data used in the research contain a number of limitations in spite of attempts to minimize measurement errors. Prior to the data collection phase, all three questionnaires were subjected to a pretest on a limited number of firms. These pre-tests revealed deficiencies in the measurement techniques and detected unsuitable and poorly worded questions. The questionnaires were revised and improved in an attempt to overcome these difficulties. However three main types of errors remain in the data, and include[4]:

1. Errors caused by the observer, namely:
   - observer variability;
   - observer bias;
   - observer-caused effects.
2. Errors resulting from the interviewee, namely:
   - lack of knowledge by the subject;
   - fallibility of the subject's memory;
   - post hoc rationalization.
3. Data preparation errors, namely:
   - coding errors;
   - keypunching errors.

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[4]Part of the catagorization scheme to outline the limitations of the data was suggested by: Julian L. Simon, *Basic Research Methods in Social Science* (New York: Random House, 1969), chaps. 6 & 7.

In addition, cost was always a major consideration in the research design. The obstacles encountered, and the steps taken to overcome these problems, are outlined below.

6.3.1 Observer Caused Errors

Researcher bias, researcher variability and researcher-caused effects were a major concern during the collection of the data. To minimize some of the effects of the humanness of the observer, as much information as possible was collected in the form of a mailed questionnaire. Secondly, in the case of the personal interviews, the questions were carefully and explicitly worded on the interview guide, operational definitions and explanations were provided, and the questions posed were designed to seek short and specific answers. Thirdly, the interviewers were carefully selected and well trained, and also were intimately involved in the preparation of the questionnaire.

6.3.2 Interviewee Caused Errors

During the design of the research and development of the questionnaires, a number of problems, which result from the human nature of the respondent, were anticipated.

1. The opinions of one or two managers in a firm might not be a true representation of the facts.

A more reliable picture of the firm and the new product projects studied, might have been obtained by interviewing a greater number of people in each firm. However, the cost of such a design is prohibitive, if the objective is to obtain a representative sampling of firms and projects to permit generalization of the research results. Moreover, the imposition of extended interviewing may be unwelcome by many firms. By interviewing the most knowledgeable managers in each firm and by sampling a relatively large number of firms, a reasonable balance of measurement reliability and measurement validity was obtained.

2. Many questions called for an opinion on the part of the manager, which may differ from reality.

In many cases, the only practical means to measure a variable was to solicit an opinion on the part of the manager. However, given the expertise of the manager, and his familiarity with the firm and its operations, the subjective assessment of variables characterizing the firm are probably a reasonable reflection of the truth, and suffer more from inconsistency than bias. Since the new product situational variables are defined as perceived by the manager, subjective assessments by managers are defensible.

The subjective measures used avoided open-ended questions and relied on Likert scales (see Appendix B). While subjective scales have their deficiencies, at least the type of response or information obtained from each manager is consistent, and coding problems are minimized.

3. The data rely on the memory of the interviewee.

Because much of the data sought were historical in nature, the questions posed necessarily rely on the memory of the interviewee. While the possibility of arranging several interviews during the course of a new product development exists, the long development times involved and the cost of extra visits renders the approach too expensive and time consuming.

4. Many historical questions were posed, which the manager may never have addressed during the development of the product.

In the case of the new product situational variables, the most practical and operational measurement method was to request the manager to place himself back during the product development phase, and to reply to questions he had perhaps never addressed at the time. Such a measure probably comes closest to guaging some combination of how the manager would have perceived the variable during the project development and how he perceived it at the time of the interview. This particular

deficiency is minimized by the relatively stable nature of many of the new product situational variables over time.

5. The responses to questions, which placed the interviewee at previous points in time, may be biased by post hoc rationalization.

To minimize errors due to post hoc rationalization, the questionnaire was carefully worded to avoid creating highly dissonant situations. For example, many questions were preceded with a preamble which was designed to make the manager feel more at ease in replying to potentially embarassing questions (see, for example, question 1.B.6 in Appendix B). In most cases, it appeared that managers truly attempted to give a realistic and unbiased description of the situation as it was, and truthful account of the facts.

6.3.3 Data Preparation Errors

Errors in the preparation of the data, including coding errors and keypunching errors, were expected to be minimal. In the case of data from the first interview, all data were double-coded and double-keypunched. Errors were detected by comparing the two separately prepared data decks. Data from the second interview and the mail-back were coded and checked, and then keypunched and verified.

The objectives of the research and the practical constraints on resources imposed limitations on the research design. However, in spite of these limitations, the major errors in measures were likely errors of inconsistency (random) rather than errors due to bias, whose main effect is to attenuate the empirical results.

6.4 METHODS OF DATA ANALYSIS

In this section, the methods utilized to analyze the research data are described,[5] and the appropriateness of each technique to the research is discussed. Figure 6.1 provides an outline of the sequence of analyses undertaken to test both sets of hypotheses.

6.4.1 Testing Hypothesis Set H_1

The nature of the hypothesized set of relationships (H_1) and the proposed mathematical representations of the Behavioral Model point to the use of multiple regression, partial correlation and multiple classification analysis as tools for the analysis of the data. These hypotheses focus on the relationships between a single continuous dependent or criterion variable, the amount of assessment, and a number of variables which characterize the new product situation, the predictor variables:

$$MA = f(X_1, X_2, \ldots\ldots X_n) \tag{6.1}$$

where X_i are the predictor variables.

MA is the amount of market assessment.

Multiple regression analysis was used to relate the criterion variable, amount of assessment, to the group of hypothesized predictor variables to test the first set of hypotheses, H_1. Not only does regression analysis provide a measure of the degree of association between the criterion and each predictor, but it also describes the nature of

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[5] All data analysis was undertaken using the Statistical Package for the Social Sciences adapted for use on the Cyber 70 computer at The University of Western Ontario. See: Norman H. Nie, Dale H. Bent and C. Hadlai Hull, *Statistical Package for the Social Sciences* (New York: McGraw-Hill, 1970).

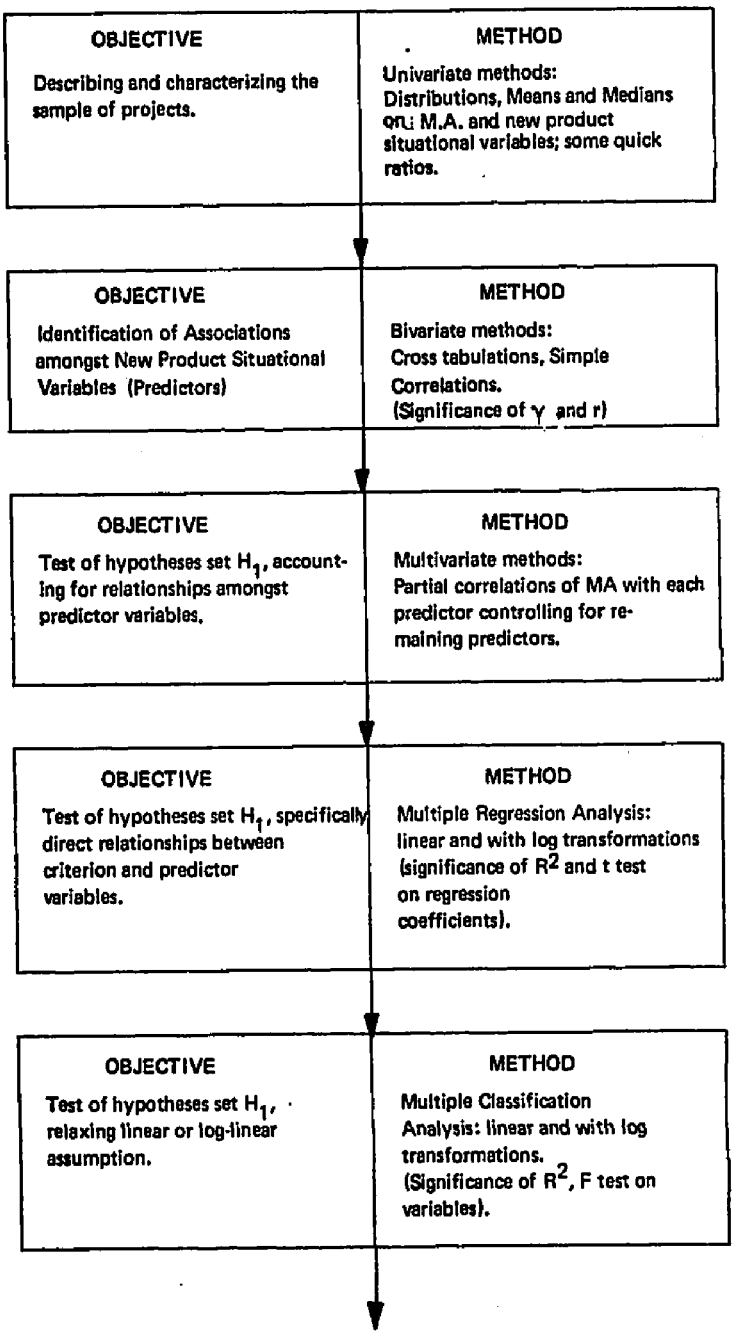

Figure 6.1. Sequence of Analyses.

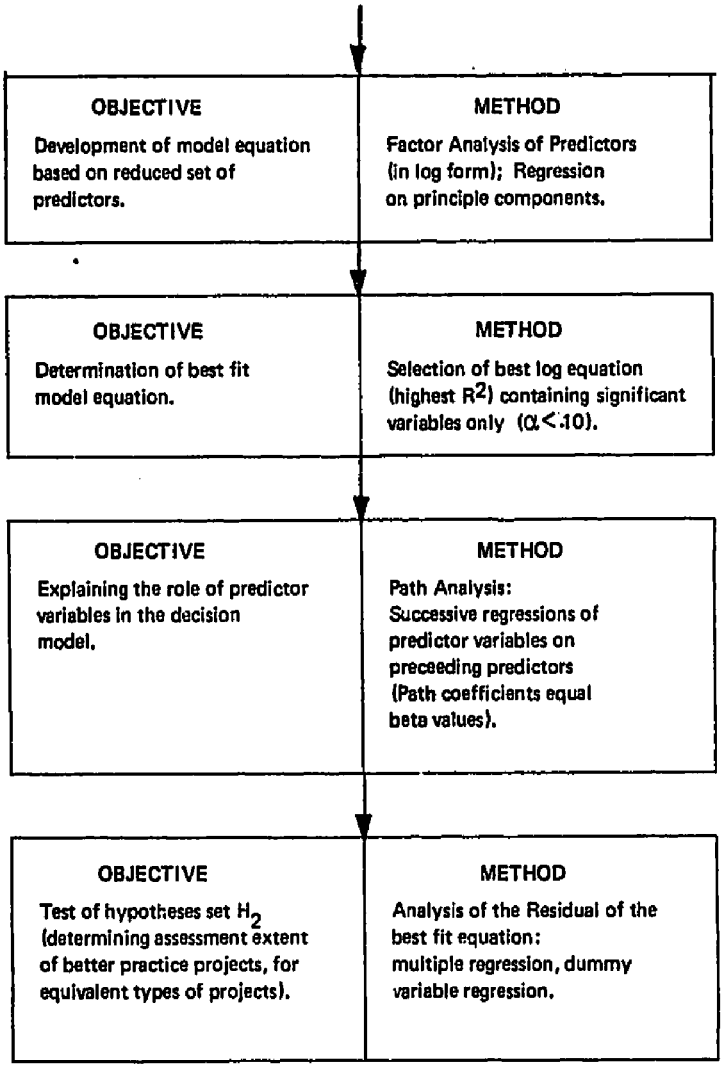

Figure 6.1 (continued). Sequence of Analyses.

the relationships.[6] The resulting best fit equation proposes a descriptive or predictive law between criterion and predictor variables.

The main assumptions in the use of multiple regression analysis include linearity and additivity, as well as normality, and homoscedasticity. Further, residuals must be pairwise uncorrelated (no autocorrelation) and should be independent of the sample selected, while no predictor can be exactly correlated with another predictor (no multicollinearity).[7] When the linearity and additivity assumptions are not met, the result is biased estimates of coefficients and higher errors in these estimates. Autocorrelation is usually only a concern in time series analysis. To test the multiplicative exponential form of the hypothesized model, logarithmic transformations of all variables permitted its reduction to a linear, additive expression.[8] The limited sample size precluded the detection of interaction effects of predictor variables on the criterion. Ordinal data, such as the Likert measures of this research, were assumed to be linear. While such an assumption is questionable, its only effect is to attenuate results in the event of non-linearity.[9]

In order to relax the linear assumption of multiple regression analysis, Multiple Classification Analysis (MCA) was used as an alternate test of the hypotheses of the Behavioral Model.[10] MCA resembles multiple regression analysis – it relates a single

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[6]See for example: Hubert M. Blalock, *Social Statistics* (New York: McGraw-Hill, 1960), Chap. 17. See also: William L. Hayes, *Statistics for Psychologists* (New York: Holt Rinehart and Winston, 1963), Chap. 15.

[7]J. Johnston, *Econometric Methods* (New York: McGraw-Hill, 1960), pp. 106-108.

[8]Arthur S. Goldberger, *Topics in Regression Analysis* (New York: MacMillan, 1968), Chap. 8.

[9]S. R. Searle and Jon G. Udell, "The Use of Regression on Dummy Variables in Management Research," *Management Science*, Vol. 16, No. 6 (February, 1970), pp. B-397 to B-409.

[10]The MCA technique was available on the SPSS package at The University of Western Ontario.

continuous variable to a set of predictor variables -- but it treats all predictor variables as nominal category data.[11] However information is lost when continuous predictor variables are categorized while the number of categories required for all predictor variables utilize a large number of degrees of freedom. The limited sample size of this research severely constrains the utility of the MCA technique.

Multiple regression analysis with factor analysis was also used to test the Behavioral Model in order to condense the number of predictor variables considered in the regression equation.[12] The number of intercorrelated predictor variables in a regression equation may be reduced to a smaller and more managable number of variables using factor analysis. The criterion variable, amount of assessment, can then be regressed against the reduced set of predictors (principle components). While useful in the event of a high degree of multicollinearity (since all predictors will be considered in the analysis), when only moderate or low degrees of multicollinearity exist, information is lost when the predictors are reduced to a set of principle factors.

Partial correlation analysis was utilized to study the effects of particular predictor variables on the criterion variable, when controlling for the effects of other predictor variables. While partial correlation analysis provides an insight into the causal effects in the model, it is not a fair test of the hypotheses: in the event of multicollinearity, only the relationship of the uncorrelated portion of the variance of a

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[11]MCA yields results analogous to those obtained with regression on dummy variables. See: Frank M. Andrews, James N. Morgan and John A. Sonquest, *Multiple Classification Analysis: A Report On a Computer Program for Multiple Regression Using Categorical Predictors* (Ann Arbor, Michigan: Survey Research Center, Institute for Social Research, University of Michigan, 1969). See also: Daniel B. Suits, "Use of Dummy Variables in Regression Equations," *Journal of the American Statistical Association*, Vol. 52 (1957), pp. 548-551.

[12]Richard B. Darlington, "Multiple Regression in Psychological Research and Practice," *Psychological Bulletin*, Vol. 69 (1968), pp. 161-182.

predictor is studied, and the apparent predictor-criterion relationship appears weaker than the magnitude of the true direct link.[13]

Path analysis was used to identify the direct and significant paths or effects between predictor variables. Path analysis is a mathematical technique for estimating the paths which may account for a set of observed correlations between a number of variables.[14] The path coefficient represents the direct effect of one variable on another when each variable is taken to be in standard form.[15] In the case of assymetric relationships (one-way relationships), the order of precedence of variables must be assumed in advance. Path analysis amounts to a sequence of regression analyses, where the independent variables are those which have a prior effect on each dependent variable considered. The beta values of the regression analyses become the path coefficients.

When the ordering of two variables is not known, by regressing each one against the other and all other preceding variables, the nature of the relationship between the two is obtained by examining the resulting beta coefficients of the two regression runs. If the two beta values between the two variables in question are statistically identical regardless of the assumed ordering of the variables, the relationship between the two variables is symmetric. The path coefficient would therefore be bidirectional.

Path analysis permits the development of a causal network – a path diagram – which demonstrates the direct effects each predictor variable has on other predictors as well as on the criterion. The method is well suited to this research: while partial

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[13]Blalock, p. 331.

[14]Otis Dudley Duncan, "Path Analysis: Sociological Examples," *The American Journal of Sociology*, Vol. 72, No. 1 (July, 1966).

[15]In the present research, the term standard form means the variable is transformed to its Z equivalent, and has a mean zero and a standard deviation of unity. See: Dunean.

correlation and factor analysis may identify the existence of a complex network of relationships, path analysis describes and explains this network.[16]

6.4.2 Testing Hypotheses Set H_2

The second set of hypotheses (H_2) concerns the relationships between the amount of assessment and various criteria of better practice, when controlling for the effects of the new product situation. The relationships may be represented as:

$$(MA|_{x_i}) = f(Z_i) \tag{6.2}$$

where $MA|_{x_i}$ = the amount of market assessment, controlling for the new product situation x_i.

Z_i = measure of better practice.

To compare the assessment levels conducted in subgroups of projects (such as better practice and poorer practice subgroups), ideally the new product situations faced in one subgroup should identically match the situations faced in the other subgroups (matched sets of situations). Except in the case of a controlled experimental study, the existence of matched subgroups is unlikely. To factor out the effects of the new product situation, the ratio of the actual amount of assessment conducted to the expected amount for the particular new product situation was used as the measure of $MA|_{x_i}$. The expected amount is predicted by the best fit equation of the Behavioral Model.

$$MA|_{x_i} = \frac{MA_a}{MP_p} = f(Z_i) \tag{6.3}$$

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[16]Duncan.

where MA_a = actual amount of assessment conducted.

MA_p = expected or predicted amount of assessment.

The ratio of actual to predicted assessment indicates how much more or less assessment was conducted relative to the amount expected for the particular new product situation faced.[17] The use of this technique – essentially a form of residual analysis – assumes that best fit regression equation of the Behavioral Model explains variations in assessment expenditures reasonably well.

Multiple regression analysis and regression analysis with dummy variables were used to study the relationships between this assessment ratio and the four measures of better practice. In the case of regression analysis, the relationships between measures of better practice and the assessment ratio were assumed to be linear. Dummy variable regression permits the classification of projects into two categories: "better practice" and "all others" (subsequently called "poorer practice"), and yields the effect of each class on the assessment ratio.

When all four measures of better practice are considered in a single multiple regression analysis, the resulting expression predicts the level of assessment for a project which meets all four criteria of better practice. This prediction is largely an extrapolation since very few projects may be classed as better practice on all four dimensions.

6.5 SUMMARY

Chapter VI has outlined the methodology utilized to test the two sets of

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[17]The ratio of actual to predicted amount of assessment is a measure of the residual of the best fit equation. Residual analysis is discussed by: Goldburger, p. 131; and N. R. Draper and H. Smith, *Applied Regression Analysis* (New York: Wiley, 1966), Chap. 3.

hypotheses of the research. A description of the selection of the sample of firms and new product projects and an outline of the methods of data collection suggested that errors of measurement were chiefly random and not due to an obvious bias. The discussion of the obstacles faced in the data collection revealed that the measures of variables, in spite of some limitations, were reasonable, given the nature of the research topic and the research resources available.

The form of the hypothesized model suggested that multiple regression analysis and related techniques – namely MCA and regression on principle components – were appropriate to test the first set of hypotheses. Partial correlation analysis was useful to identify the existence of a network of relationships among predictor variables, while path analysis described the relationships of this network.

To test the second set of hypotheses, relationships between a residual measure of market assessment expenditures and four criteria of better practice were studied using multiple regression analysis and regression analysis on dummy variables. The residual measure factored out the effects of the new product situation.

CHAPTER VII

MAJOR EMPIRICAL FINDINGS

7.1 INTRODUCTION

Chapter VII reports the major empirical findings of the research. The Behavioral Model developed in Chapter III yielded a set of hypotheses (H_1) which postulates that the amount of market assessment undertaken in a new product is determined by the new product situation, and specifically by variables which describe the amounts at stake, the uncertainties and probabilities of the situation, and the cost of market information. It was also hypothesized (H_2) that better practice projects are characterized by more market assessment for equivalent new product situations. Chapter VI outlined both the methods of data collection and the data analysis techniques employed to test these hypotheses. The present chapter reports the results of these analyses.

This chapter begins with a brief overview of the general characteristics of the sample, which help describe the 118 successful new product ventures studied. Next, the results of the tests of the first set of hypotheses (H_1) and a best fit Behavioral Model equation are presented. The role of each new product situational variable in the model is revealed, using path diagrams to indicate the direct and indirect effects of each model variable on the amount of market assessment undertaken. Finally, the results of the tests of the second set of hypotheses (H_2) are reported.

7.2 GENERAL STATISTICS

A review of the main characteristics of the projects studied revealed the nature of the typical new product venture in the sample. Table 7.1 presents mean and median values of some variables which might be used to characterize a new product project. In addition, Table C.1 in Appendix C indicates the distributions of all variables which characterize the new product situation.

The mean and median values of Cost of Failure, F, Sales, S, Profits, PR, and Discounted Profits, DPR, indicate the magnitudes of the amounts at stake in the projects. The sample of projects considered was evidently comprised of a large number of smaller projects (low medians) and several large projects (higher means). The highly skewed nature of the distribution of the amounts at stake was not unexpected.

A comparison of the various measures of the amounts at stake in the projects revealed the potentially lucrative nature of new product development to industrial goods firms. Sales, Profits, and Discounted Profits far exceeded the Possible Costs of Failure. The respectable profit margins and very short payback periods supported this view. However, only successful projects were considered in the sample, and a complete picture including failure products may have revealed a different pattern.

Expenditures on market assessment appeared to play a relatively minor role in the new product development process. The mean number of manhours of market assessment per project was 721 manhours, while less than 218 manhours of assessment were spent on half the product ventures. When market assessment manhours were compared to the possible gains (S and PR) and losses (F) in projects, the mean and median ratios were notable for their low values. Assuming that market assessment costs roughly $10 per manhour (which is equivalent to about

TABLE 7.1

STATISTICS CHARACTERIZING THE SAMPLE OF PROJECTS

Variable Name	Symbol	Units	Mean	Median
Amount of Assessment	MA	hours	721.2	218.0
Possible Cost of Failure	F	$000	484.0	96.4
Anticipated Average Annual Sales	S	$000/yr	2227.0	344.5
Anticipated Average Annual Profits	PR	$000/yr	678.9	118.7
Profit discounted at 15%	DPR-1	$000	3295.0	751.3
Profit discounted at 25%	DPR-2	$000	2378.8	509.5
Profit discounted at 40%	DPR-3	$000	1471.3	242.6
Profit discounted at 50%	DPR-4	$000	1126.0	166.8
Profit Margin	PM	%	34.7	36.0
Payback Period	PP	years	2.19	1.52
Ratio of S:F	S/F	/year	18.45	3.50
Ratio of PR:F	PR/F	/year	5.47	0.94
Ratio of DPR: F (at 15%)	DPR/F	dimensionless	29.60	5.27
Ratio of MA:F	MA/F	hrs/$000	10.93	2.53
Ratio of MA:S	MA/S	hrs/$000	2.19	0.568
Ratio of MA:PR	MA/PR	hrs/$000	6.58	2.02

Note: all profit figures are reported before taxes.

$20,000 per manyear), the median value of market assessment expenditure as a percent of Possible Cost of Failure was only 2.35%. Similarly, the median values of assessment expenditures as percents of Sales and Profits were only 0.6% and 2.0%.

7.3 TESTING HYPOTHESIS SET H_1

7.3.1 An Overview

The first set of hypotheses focussed on relationships between the amount of assessment conducted and those variables which characterize a new product situation. Seven of these hypothesized relationships were found to be statistically significant ($\alpha < .10$) when multiple regression analysis was used to test the hypotheses. The main determinants of the amount of assessment conducted in the 118 new product projects studied were:

- S Anticipated Annual Sales.
- F Possible Cost of Failure.
- PN Product Newness to the Market.
- PI Importance of the Purchase.
- PP Payback Period.
- NC Number of Customers.
- MS Number of Market Segments.

The directions of effect of six of these seven significant variables concurred with the hypotheses stated, while the significant variables themselves described all three constructs in the Behavioral Model – the amounts at stake, the uncertainties and probabilities, and the cost of information. Moreover, in spite of the subjective nature of managers' responses and the assumptions and limitations of the Behavioral Model, the best fit regression relationship between assessment expenditures and the seven significant variables explained 40% of the variance in the amount of assessment

conducted ($\alpha < .001$). A summary of the results of the tests of hypothesis set H_1 is presented in Table 7.2.

7.3.2 Results of Analyses

The principle tests of the Behavioral Model hypotheses (H_1) were based on multiple regression analysis, while the results with other techniques also supported the regression findings. Multiple regression analysis was used to generate a relationship between the amount of market assessment (criterion variable) and the new product situational variables (predictor variables) based on the 118 projects studied. Both multiplicative exponential and linear additive regression models were tested. The relationship, which best described the data and included only significant predictor variables, identified seven significant determinants of market assessment expenditures, and had the following multiplication form:

$$MA = 14.86\ (F)^{.185}\ (S)^{.364}\ (MS)^{-.568}\ (NC)^{.094}\ (PP)^{.164}\ (PI)^{.316}\ (PN)^{-.583} \qquad (7.1)$$

where MA = manhours of market assessment.

The detailed results of the best fit regression relationship are presented in Table 7.3. This multiplicative exponential equation was obtained by the successive reduction of an equation containing all predictor variables, until only significant variables remained ($\alpha < .10$).[1]

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[1] A variety of methods are available for inclusion or exclusion of predictor variables. The stepwise method available in the SPSS package selects predictor variables on the basis of their beta value and tolerance, which yields an indication of the per cent additional variance explained by adding the new variable. However, this approach has the disadvantage of possibly introducing statistically insignificant variables before all significant variables are entered. Therefore, to obtain a best fit equation containing the set of significant variables which explain the most variance in MA, predictor variables with the lowest F values were successively eliminated from the equation containing all predictors until only significant variables remained.

TABLE 7.2

RESULTS OF THE TEST OF HYPOTHESIS SET H_1

The amount of market assessment conducted during the development of an industrial new product is related to:				
Hypothesis Number	Variable Symbol	Variable Name	Hypothesized Effect	Result of Test of Hypothesis
		Amounts at Stake		
$H_{1.1}$	R	Anticipated payoffs if the product is a success	positive	SUPPORTED
$H_{1.2}$	F	Possible cost of failure	positive	SUPPORTED
$H_{1.3}$	RF	Relative cost of failure	positive	not supported
		Uncertainties and Probabilities		
$H_{1.4}$	MN	Newness of the product market to the firm	positive	not supported
$H_{1.5}$	SM	Stability of the market for the product	negative	not supported
$H_{1.6}$	PN	Newness of the product to the market	positive	REVERSED EFFECT
$H_{1.7}$	DC	Degree of competition in the product market	negative	not supported
$H_{1.8}$	PC	Product complexity	positive	not supported
$H_{1.9}$	PTN	Purchase task newness	positive	not supported
$H_{1.10}$	TN	Technical newness of the product to the firm	positive	not supported
$H_{1.11}$	PI*	Importance of the purchase	positive	SUPPORTED
$H_{1.12}$	PP	Payback period	positive	SUPPORTED
		Cost of Market Information		
$H_{1.13}$	NC	Number of potential customers for the product	positive	SUPPORTED
$H_{1.14}$	MS	Number of market segments	negative	SUPPORTED
$H_{1.15}$	CA	Customer accessibility (for market information)	positive	not supported
$H_{1.16}$	TU	Time urgency of development	negative	not supported

Hypotheses supported, one tail t-test, $\alpha \leq .10$. Reversed effect based on two tail t-test, $\alpha \leq .10$.

*Only one of the four measures of PI, time effect on customer, was significant (see Table 6.1 for a listing of the four measures).

TABLE 7.3

RESULTS OF BEST FIT REGRESSION EQUATION

Variable	Regression Coefficient	Beta	t	α	Cumulative R^2
F	.18455	.21349	2.17	< .025	.258
S	.36382	.38522	4.20	< .001	.325
MS	-.56846	-.18033	2.16	< .025	.361
PP	.16373	.12805	1.59	< .10	.368
NC	.09443	.12144	1.57	< .10	.377
PN	-.58318	-.15330	1.84	< .05	.388
PI-3*	.31563	.11478	1.37	< .10	.400

Constant = 2.6983

R^2 = .400

F = 10.415

$F_{.999}$ = 3.77

Notes: Equation based on a logarithmic transformation of all variables; α based on one tail t-test.

*Purchase Importance was measured in four ways (see Table 6.1). These are designated:

PI-1 = selling price
PI-2 = order size
PI-3 = time length effect on customer
PI-4 = effect on customers' profits

An examination of both the correlation matrix of the hypothesized predictor variables and cross tabulations between all pairs of predictors indicated the existence of a large number of associations among the predictor variables: every predictor variable was related (r or γ significant, $\alpha < .10$)[2] to two or more other predictor variables, and in some cases to more than ten other predictor variables. However with several exceptions (specifically between the amounts at stake, and also between the several measures of PI) these associations were not so strong as to invalidate the results of the regression analysis ($\gamma \leq .4$; $r \leq .5$).

Both the assumptions of normality and homoscedasticity, inherent in the use of regression analysis, were approximately met in the case of the multiplicative regression equation (7.1). With one possible exception, the distributions of the logarithmic transformations of equation variables were very close to normal distributions, while residual analysis indicated that the residual errors were not significantly related to values of predictors (χ^2 test, $\alpha \leq .10$).[3]

In the case of six of the seven significant predictor variables, the directions of effect concurred with the stated hypotheses. However, the empirical relationship between Product Newness and MA did not agree with hypothesis $H_{1.6}$. In the case of PN, this possibility was anticipated during the development of the Behavioral Model. The reasons for this apparent inconsistency are discussed in a later section.

As expected, the best fit multiplicative form of the model ($R^2 = .40$) was

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[2]Gamma (γ) is a measure of the relationship between a pair of rank ordered (ordinal) variables. See: M. G. Kendall, *Rank Correlation Methods* (London: Griffin, 1970).

[3]The normality assumption was checked by an analysis of the kurtosis and skewness of distributions, as well as by the determination of the per cent of cases between plus or minus one standard deviation from the mean. The distribution of PI-3 appeared less peaked (negative kurtosis) than the normal distribution.

found to describe the market assessment decision better than the best fit linear form (R^2 = .32). This was also true when all predictor variables were included in both linear and multiplicative forms of the analysis.

When all five proposed payoff functions were studied in separate regression analyses, the Annual Sales measure was found to be most significant and yielded the greatest improvement in the multiple R^2 when entered in the regression equation. However the other payoff functions (Average Annual Profits and Discounted Profits at four discount rates) were all highly correlated with Annual Sales, and when considered in separate regression analyses, were all significantly related to MA ($\alpha < .05$).

The results of other methods of analyses utilized to test the first hypothesis set (H_1) in general concurred with the regression findings. While these other techniques did not provide the most appropriate test of the hypotheses, they served to clarify and check the regression results.

The best fit relationship obtained using multiple regression analysis on principle components was inferior to the model expression developed with traditional multiple regression analysis. The hypothesized predictor variables, in logarithmic form, were factor analysed using the method of principle components with iterations and Varimax rotation. Eight factors were generated with only four having eigen-values in excess of 1.0. Communalities (proportion of variance of a variable explained by the generated factors)for most variables were low, indicating a loss of information in the reduction of variables to principle components. (Table C.2 in Appendix C presents the results of this factor analysis.) Composite factor indices were constructed from the factor scores and the new product situational variables in standard form for each of the 118 cases. The resulting regression relationship between amount of assessment and the eight composite factor indices (principle components) explained only 33% of the variance in MA, while only two principle components were statistically significant

($\alpha<.10$). The single factor explaining most of the variance was heavily loaded on two measures of the amounts at stake, the Possible Cost of Failure and Annual Sales (see Table C.2, Appendix C).

The results of the linear and logarithmic Multiple Classification Analysis (MCA) also showed no improvement over those of the regression analysis. While MCA has the advantage of relaxing the linear or log-linear assumptions imposed on the predictor variables, the technique requires that all predictor variables be in category form. In the case of continuous variables (such as F and S), information was lost when these variables were categorized, while the number of degrees of freedom utilized for categorized variables, in view of the limited sample size of this research, limits the applicability of the MCA technique. The adjusted R^2 in the case of the logarithmic MCA analysis was actually less than in the corresponding regression analysis.[4] However, the MCA method yielded results which were consistent with the regression analysis – it revealed that the multiplicative form of the Behavioral Model provided the best fit expression and it identified the same set of significant predictor variables (one tailed F test,$\alpha<.10$), namely: F, S, PP, PN, PI, MS and NC. In the case of nominal data, there was no evidence of curvilinearity, while the shapes of the relationships generated in the MCA analysis supported the log-linear assumption of the best fit regression analysis.

The results of partial correlation analysis also concurred with the regression findings. When all other new product situational variables were held constant, five hypothesized predictor variables (in logarithmic form) were found to be significantly related to MA ($\alpha<.05$, one-tail t-test) namely: F, S, NC, MS and PP. Another six

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[4] R^2 was adjusted for the large number of degrees of freedom utilized by the MCA technique.

predictor variables, PN, DC, PC, PI-3, CA-2 and TU, were significant at the 0.20 level. Partial correlation does not provide an appropriate test of the hypotheses since the partial correlation coefficient, unlike the beta coefficient of regression analysis, does not yield a measure of the direct link between each predictor and the criterion variable. However, the results of the partial correlation analysis revealed the existence of a network of effects amongst predictor variables which the traditional regression methods failed to identify.

7.3.3 Discussion of Results

The empirical findings of the regression, MCA and partial correlation analyses identified the major determinants of new product market assessment expenditures, and also revealed that such expenditures were fairly predictable. The two most important and most significant variables which appeared to determine the amount of assessment were the Possible Cost of Failure, F, and the Anticipated Annual Sales, S.[5] Both variables proport to describe a single construct in the model – the amounts at stake. The strengths of these relationships was not surprising. In the first place, the measures of F and S were likely superior to the measures of most other predictor variables. Both variables were continuous (rather than interval or ordinal) and were also more operational in terms of concrete and objective measures. Secondly, it is reasonable that managers consider the amounts at stake as key determinants of market assessment expenditures. The amounts at stake, because they are so obvious to managers, may be the main factors which characterize a new product venture. Moreover,

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[5]The beta value from the regression analysis has been recommended as one measure of the importance of a predictor variable. F and S had the largest beta values. See: Richard B. Darlington, "Multiple Regression in Psychological Research and Practice," *Psychological Bulletin*, Vol. 69 (1968), pp. 161-182.

descriptive findings and a normative analysis both reveal that the amounts at stake are probably the most important variables in determining the level of information acquisition.

What is surprising is that the most significant payoff function equalled the Annual Sales of the product, rather than some measure of profitability. A plausible explanation is that, during the development of a new product, expected profit margins may have been either unknown to the manager or were fixed by corporate policy (a cost plus fixed mark-up pricing). Therefore expected sales became the main measure of the possible payoffs.

The empirical evidence revealed that a third variable describing the amounts at stake, RF, the Relative Cost of Failure, was not significantly related to amount of assessment MA. The measure itself, an ordinal scale, may be questioned, but the evidence of significant and reasonable correlations with seven other predictors suggested that the reliability of the RF measure was significant.[6] An examination of the measure used (Appendix B) did not point to any obvious reasons why the measure might be invalid. It may be that the Relative Cost of Failure was an inappropriate indicator of the disutility of the possible losses in a project, or that in the minds of managers, absolute figures rather than relative values were the major components of the amounts at stake in a new product venture.

A surprising discovery was that so few variables which describe the uncertainties and probabilities of the situation were significantly related to MA. Of the nine variables which were expected to affect perceptions of probabilities and uncertainties, and hence the amount of assessment, only three were significantly related to MA. One

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[6]RF was found to be correlated with seven other predictor variables in simple correlation analyses ($\alpha < .10$, two tail t-test).

of these, PN, was related in a negative fashion, and therefore its effect on probabilities and uncertainties appeared to be much less than its effect on the perceived cost of information. The two variables, which describe uncertainties and probabilities and were related to MA in the expected manner, both describe a time dimension: Payback Period, PP, describes the time required for the project profits to cover its dispersements, and hence is a measure of the uncertainties due to a longer time horizon. Similarly, the time effect on customers, PI-3, a measure of Purchase Importance, indicates how long the customer will be affected by the purchase and the uncertainties which exist if the product is developed and marketed without benefit of market information.

The fact that less market assessment was actually undertaken in the case of totally new products to the market (PN) was not only unexpected but revealed a major deficiency in market assessment practices. In the development of the Behavioral Model, it was suggested that increasing PN would increase the value of market information, by creating greater market uncertainties, and also would increase the perceived cost of information. However the effects on perceived value were expected to far outweigh the increase in perceived cost. The direct, significant and negative link between PN and MA, suggested that in practice, managers tended to see a high cost of doing market assessment in the case of products new to the market, and nowhere near the degree of uncertainties expected in this situation. The apparent lack of a perceived need for market information may stem from a state of over-confidence: the firm's product was so new and so much better that it could not fail, and the expected feelings of apprehension and uncertainty were dispelled. The high perceived cost of market information may result from the fear of disclosing the product concept to competitors during the market assessment phase, and the costs to the firm in the event of competitive moves. A more general and likely explanation is that managers

saw the task of undertaking marketing research for a totally new product as a particularly difficult one – the market was not well defined, and it was difficult to research a new product concept. Lacking the necessary skills and knowledge required for the task, managers tended to inflate their perceived costs of market assessment.

The fact that none of the other three measures of newness, namely Market Newness, Technical Newness and Purchase Task Newness, were significantly related to assessment expenditures was quite unexpected. Perhaps these and the other variables which describe uncertainties and probabilities (Product Complexity, Degree of Competition and Market Stability) were poorly measured. While these measures were weaker than some (ordinal scales) and were based on subjective perceptions of managers, each variable was nevertheless significantly and directly linked to other measures of uncertainty (Table 7.4 in the next section reports the direct links among predictor variables), and in the fashion one might expect. The consistency of these network relationships suggested that the reliability of the measures were significant.

Apparently, there existed no strong links between the amount of assessment undertaken and many variables, which proport to measure uncertainties and probabilities. Conceivably, the manager had difficulty translating these intangible variables and his feelings of apprehension into specific levels of market assessment. Moreover a normative analysis suggests that changes in probabilities and uncertainties are much less important in determining search expenditures than are the amounts at stake. In the particular case of the three dimensions of newness (MN, TN and PTN), increases in the perceived cost of search may have cancelled the effects of increases in the perceived value of information.

The significant and expected effects of the Number of Customers and Number of Market Segments on the amount of assessment, as well as the negative relationship between PN and MA, revealed that the perceived cost of market information played a

more important role in the expenditure decision than a review of previous empirical search findings might have suggested. More surprising was that cost factors were so important when the actual cost of market assessment was so small in proportion to the total amounts at stake in the projects.[7] It would appear that the true dollar costs of conducting a market study were not consciously considered in relation to the magnitudes of the projects, and that psychological factors caused managers to inflate these costs far above their true dollar figures. That MA was unrelated to two variables, Time Urgency and Customer Accessibility, supported this view. It can be logically argued that a lack of time available or the existence of inaccessible customers (for purposes of gathering market information) would seriously constrain the amount of assessment which could be undertaken. Perhaps assessment levels were generally so low for other reasons, that the usual physical limits to assessment, such as cooperation and time, were never reached, and hence these variables had no signifant effect on MA.

As expected, the best fit relationship had a multiplicative rather than additive form. A normative analysis and an intuitive appreciation of the interaction between the three constructs in the model suggested that the multiplicative result was logical.

The best fit relationship, which identified seven significant predictor variables and also explained 40% of the variance in MA, tended to support the hypothesized Behavioral Model. However, the high unexplained variance suggested that the model was not a complete descriptive representation. During the development of the Behavioral Model, a number of possible limitations and errors were discussed. These include the static nature of the model as well as the effects of a great many variables

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[7]Costs of market assessment represented only 2.53% (median value) of the possible cost of failure, and 2.02% (median value) of the expected annual profits for the projects. See Table 7.1.

describing the organization and managers involved. No doubt a significant portion of the unexplained variance was attributable to these factors, as well as to the errors in the measures used in the research.

To the extent the best fit relationship describes managers' assessment expenditures in terms of rationally selected situational variables, it approaches the definition of a Management Coefficients Model. Therefore the resulting empirical equation, called the Average Manager Model (equation 7.1), may provide useful prescriptive inputs to future managerial decisions on assessment expenditures. The normative implications and use of the Average Manager Model are presented in the next chapter.

7.3.4 The Role of Predictor Variables

Although only seven of the 16 hypothesized predictor variables[8] proved to be significantly related to the amount of assessment using regression analysis, it was found that 15 of the 16 variables in fact did play a statistically significant role in the Behavior Model. A statistically significant role in the model is defined when a variable is either:

- significantly and directly related to the criterion, amount of assessment (there were seven such direct variables), or
- significantly and directly related to another predictor, which in turn is significantly and directly related to the criterion, amount of assessment (there were eight such indirect variables).

Path analysis was used to identify the direct and statistically significant paths which exist between predictor variables. The path coefficient represents the

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[8]Two of the predictor variables were measured in several ways: PI, Purchase Importance, had four measures, while Customer Accessibility had two measures, for a total of 20 measures of the 16 variables.

direct effect of one variable on another when each variable is in standard form, and in the case of symmetric (two-way) relationships, the bidirectional effects.

In the case of the Behavioral Model of this research, relationships between predictor variables were generally expected to be symmetric: for example, the direction of effect between anticipated payoffs and possible losses was indeterminate. Therefore, the assumed ordering of variables had little effect on the results of the path analysis.[9] The orders of precedence assumed for the predictor variables are shown in Figure 7.1.

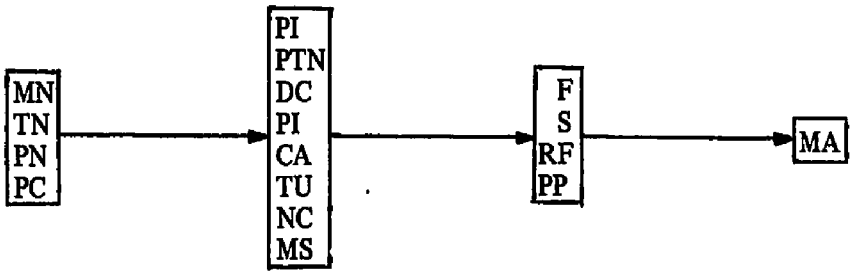

Figure 7.1 Assumed Ordering of Predictor Variables.

The significant path coefficients ($\alpha < .10$, two tail t-test) are reported in the form of a path coefficient matrix in Table 7.4. The only hypothesized predictor variable which was not directly related to any of the other predictor variables is RF, the Relative Cost of Failure. The number of significant paths and variables was too great for a simple and clear graphical representation or path diagram. Therefore, a tabular substitute for the complete path diagram was developed (Table 7.5), which includes

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[9]Where the directions of effects between two predictor variables was indeterminate or thought to be symmetric, two analyses were undertaken, each assuming one of the two possible directions of effect. In all such cases, the magnitudes of the resulting two path coefficients were not statistically different, indicating the existence of bidirectional effects.

TABLE 7.4

MATRIX OF SIGNIFICANT PATH COEFFICIENTS

	MN	PN*	TN	PC	SM	DC	PTN	PI-1	PI-2	PI-3*	PI-4	NC*	MS*	CA-1	CA-2	TU	S*	F*	RF	PP*
MN																				
PN*																				
TN	.198	.252																		
PC		.258																		
SM				-.165																
DC		-.254		-.171																
PTN			.196	.156		-.157														
PI-1																				
PI-2								.253												
PI-3*		.229					-.165	.351												
PI-4							.209		.344											
NC*		.346				.233														
MS*	.191								-.181											
CA-1		.285		-.181		-.205														
CA-2						.189	-.153	-.228												
TU		.203		.175		.251						-.255								
S*					-.139	.175	.173			-.244						.180				
F*		-.172							.202	.173						.157	.516			
RF																				
PP*				.200		-.154	-.207			-.216								.356		

*denotes variable directly and significantly related to MA. Path coefficients significant at 0.10 level, two tail t-test.

only those 15 predictor variables having a significant role in the model. Table 7.5 lists the direct relationships of each predictor variable with the other predictors, and illustrates these links by a series of simple path diagrams.[10]

The many significant and direct relationships between hypothesized predictor variables in the Behavioral Model pointed to the existence of a complex network model. Evidently, the relationships between the hypothesized predictor variables and MA were less straightforward than originally postulated in the development of the Behavioral Model. This network of relationships helped to explain why only a limited number of hypotheses in set H_1 were supported: with one exception, every hypothesized variable did play a significant role in the model, although in the case of eight of these variables, the effect on MA was an indirect effect.

A summary of the major findings which resulted from the test of the first set of hypotheses is presented in Table 7.6.

7.4 TESTING HYPOTHESIS SET H_2

7.4.1 Analyses Results

Those projects which were characterized as better practice had significantly more market assessment conducted during the venture than did the other projects for the same types of new product situations ($\alpha<.10$). For equivalent new product situations, more assessment was conducted in projects:

- undertaken by very large firms (annual sales $\geq$ \$100 million)

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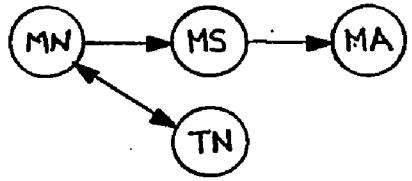
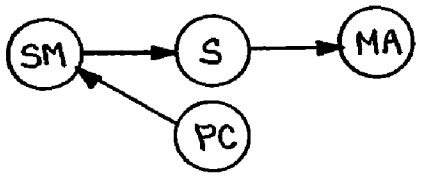
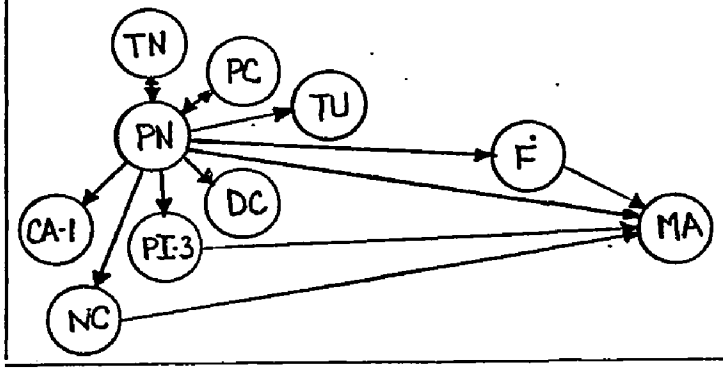
[10]If all the path diagrams in Table 7.6 were superimposed on one another, the result would be a complete path diagram of all links amongst predictor variables.

TABLE 7.5

DIRECT RELATIONSHIPS BETWEEN NEW PRODUCT SITUATIONAL VARIABLES

Path Diagrams	Path Relationships	Variable Symbol	Path Coefficient
	Market newness to the firm is directly linked to:	MN	
	Technical newness	TN	.198
	Number of market segments	MS*	.191
	Market stability is directly linked to:	MS	
	Product complexity	PC	-.165
	Anticipated payoffs (annual sales)	S*	-.139
	Product newness to the market is directly linked to:	PN*	
	Technical newness	TN	.252
	Product complexity	PC	.258
	Degree of competition	DC	-.254
	Purchase importance (time effect)	PI-3*	.229
	Number of customers	NC*	.346
	Customer willingness to cooperate	CA-1	.283
	Time urgency of development	TU	.203
	Possible cost of failure	F*	-.172

*denotes variables directly and significantly related to amount of assessment, MA ($\alpha \leq .10$) Only significant path coefficients are shown ($\alpha \leq .10$)
Arrows show assumed directions of path relationships.

TABLE 7.5 CONTINUED

RELATIONSHIPS BETWEEN VARIABLES

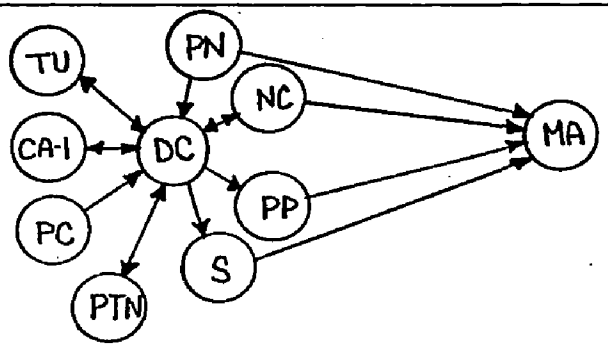
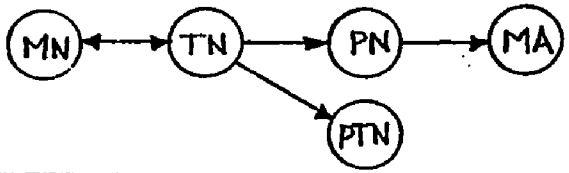
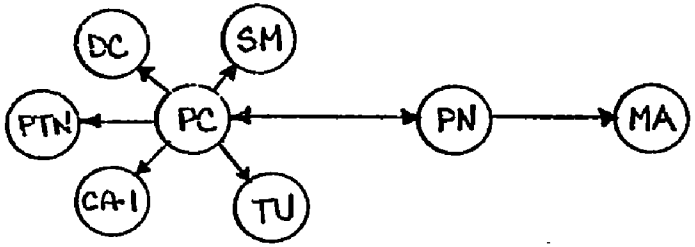
Path Diagrams	Path Relationships	Variable Symbol	Path Coefficient
	Degree of competition in the product market is directly linked to:	DC	
	Product newness	PN	-.254
	Product complexity	PC	-.171
	Purchase task newness	PTN	-.157
	Number of customers	NC	.233
	Customer willingness to cooperate	CA-1	-.205
	Time urgency of development	TU	.251
	Anticipated payoffs (annual sales)	S*	.175
	Payback period	PP*	-.154
	Technical newness of the product to the firm is directly linked to:	TN	
	Market newness	MN	.198
	Product newness	PN*	.252
	Purchase task newness	PTN	.196
	Product complexity is directly linked to:	PC	
	Product newness	PN*	.258
	Stability of the market	SM	-.165
	Degree of Competition	DC	-.171
	Purchase task newness	PTN	.156
	Customer willingness to cooperate	CA-1	-.181
	Time urgency of development	TU	.175

TABLE 7.5 CONTINUED

RELATIONSHIPS BETWEEN VARIABLES

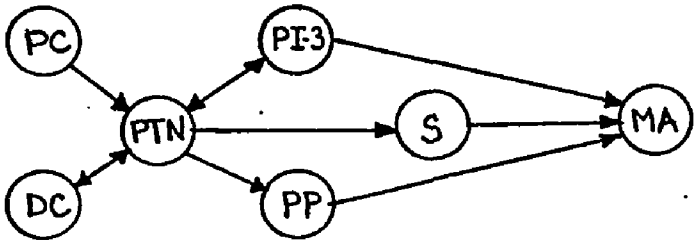
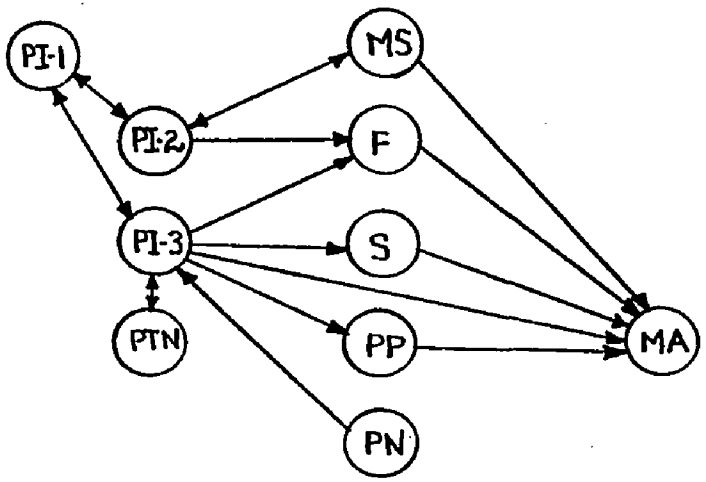
Path Diagrams	Path Relationships	Variable Symbol	Path Coefficient
	Purchase task newness is directly linked to:	PTN	
	Technical newness	TN	.196
	Product complexity	PC	.156
	Degree of competition	DC	-.157
	Purchase Importance (time effect)	PI-3*	-.165
	Anticipated payoffs (annual sales)	S*	.173
	Payback period	PP*	-.207
	Purchase Importance (selling price) is directly linked to:	PI-1	
	Purchase importance (order size)	PI-2	.253
	Purchase imporance (time effect)	PI-3*	.351
	Purchase importance (order size) is directly linked to:	PI-2	
	Purchase importance (selling price)	PI-1	.253
	Number of market segments	MS*	-.181
	Possible cost of failure	F*	.202
	Purchase importance* (time effect) is directly linked to:	PI-3*	
	Product newness	PN*	.229
	Purchase task newness	PTN	-.165
	Purchase importance (selling price)	PI-1	.351
	Anticipated payoffs (annual sales)	S*	-.244
	Possible cost of failure	F*	.173
	Payback period	PP*	-.216

TABLE 7.5 CONTINUED

RELATIONSHIPS BETWEEN VARIABLES

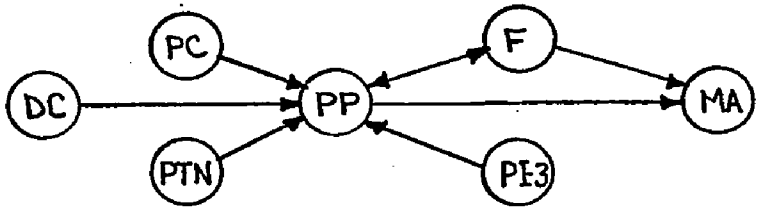
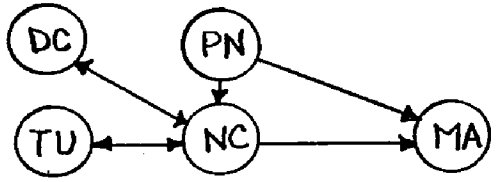
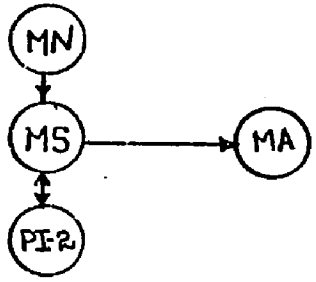
Path Diagrams	Path Relationships	Variable Symbol	Path Coefficient
	Payback period* is directly linked to:	PP*	
	Product complexity	PC	.200
	Degree of competition	DC	-.154
	Purchase task newness	PTN	-.207
	Purchase importance (time effect)	PI-3*	-.216
	Possible cost of failure	F*	.356
	Number of customers* is directly linked to:	NC*	
	Product newness	PN*	.346
	Degree of competition	DC	.233
	Time urgency of development	TU	-.255
	Number of market segments* is directly linked to:	MS*	
	Market newness	MN	.191
	Purchase importance (order size)	PI-2	-.181

TABLE 7.5 CONTINUED

RELATIONSHIPS BETWEEN VARIABLES

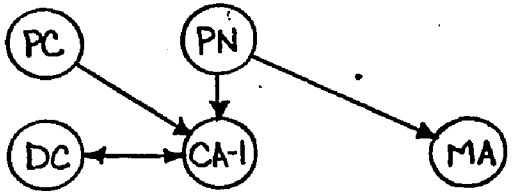
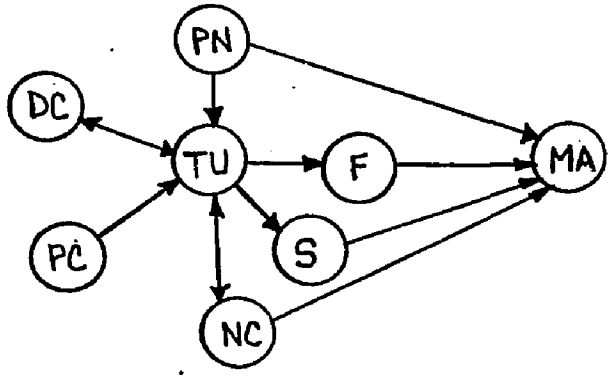
Path Diagrams	Path Relationships	Variable Symbol	Path Coefficient
	Customer willingness to cooperate (accessability) is directly linked to:	CA-1	
	Product newness	PN*	.283
	Product complexity	PC	-.181
	Degree of competition	DC	-.205
	Time urgency of development is directly linked to:	TU	
	Product newness	PN*	.203
	Product complexity	PC	.175
	Degree of competition	DC	.251
	Number of customers	NC*	-.255
	Anticipated payoffs (annual sales)	S*	.180
	Possible cost of failure	F*	-.157

TABLE 7.5 CONTINUED

RELATIONSHIPS BETWEEN VARIABLES

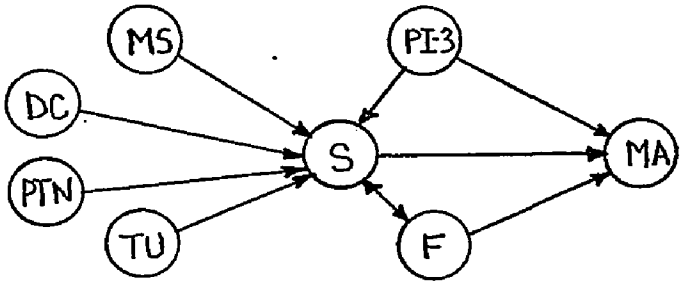
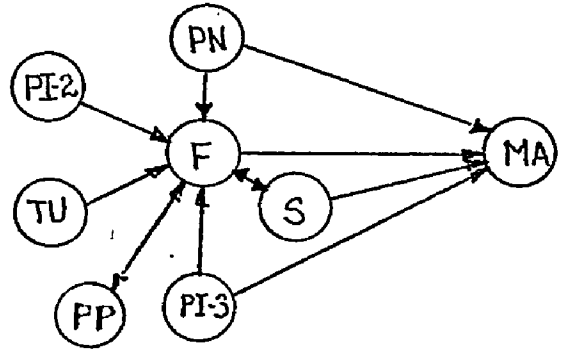
Path Diagrams	Path Relationships	Variable Symbol	Path Coefficient
	Anticipated payoffs* (annual sales) is directly linked to:	S*	
	Stability of the market	MS	-.139
	Degree of competition	DC	.175
	Purchase task newness	PTN	.173
	Purchase importance (time effect)	PI-3*	-.244
	Time urgency of development	TU	.180
	Possible cost of failure	F*	.516
	Possible cost of failure* is directly linked to:	F*	
	Product newness	PN*	-.172
	Purchase importance (order size)	PI-2	.202
	Purchase importance (time effect)	PI-3*	.173
	Time urgency of development	TU	-.157
	Expected payoffs (annual sales)	S*	.516
	Payback period	PP	.356

TABLE 7.6

SUMMARY OF MAJOR EMPIRICAL FINDINGS: TEST OF HYPOTHESIS SET H_1

1. Seven hypothesized predictor variables are significantly and directly related to amount of assessment.
2. The directions of six of these relationships concur with the hypotheses. (set H_1).
3. The best fit regression equation explains 40% of the variance in amount of market assessment undertaken in projects.
4. The multiplicative model provides the best fit relationship.
5. Expected annual sales is the best payoff function.
6. Regression on Principle Components and MCA yield inferior best fit models.
7. Results of MCA and Partial Correlations support the regression findings.
8. Fifteen of the sixteen hypothesized predictor variables play a significant role in the complex network of relationships of the Behavioral Model.

- undertaken by firms employing at least one full time market assessor;
- where initial errors in estimates of market factors were satisfactorily reduced;[11]
- undertaken in firms with "extremely successful" new product development programs (self rating).

These results are summarized in Table 7.7, which also compares the amount of market assessment conducted in better practice projects to the amounts in the average project and also to the assessment expenditures of projects not classified as better practice (poorer practice projects) on each dimension of better practice.

The residual of the best fit Behavioral Model equation was used as the measure of the ratio of actual to predicted assessment expenditures to test the hypothesis set, H_2. Since the best fit equation is based on a logarithmic transformation, its residual equals the ratio of actual to predicted amount of assessment.[12] Multiple regression analysis and regression analysis with dummy variables were used to study the relationships between residual assessment expenditures and the four criteria of better practice. The results shown in Table 7.7 are those generated by regression with dummy variables[13]: the residual MA was regressed against each measure of better

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[11]A satisfactory reduction in initial errors of market estimates is the situation where initial errors in estimates of both the desired product characteristics and the sales volume were at least halved in the time between the beginning of the project and commercialization. Errors in selling price were too small and infrequent to adequately discriminate between poor and good error reduction.

[12]The residual equals the difference of two logarithms: residual = log MA_a - log MA_p, which equals the logarithm of the ratio: log (MA_a/MA_p).

[13]A conventional regression analysis with dummy variables was used in lieu of the MCA technique. Variables were dichotomous and also had been previously coded in dummy variable form, that is, in (0,1) format.

TABLE 7.7

LEVELS OF MARKET ASSESSMENT IN BETTER PRACTICE PROJECTS

Better Practice Measure	Significance*	Ratio of market assessment in better practice project compared to levels in:	
		Average Projects	Poorer Practice Projects
Very large firms (sales ≥ $100 million)	.001	3.45	4.04
Firms with one or more market assessors	.025	1.92	2.21
Projects with satisfactory error reductions in market estimates	.06	1.62	1.92
Firms with new product programs rated extremely successful	.05	3.00	3.23

* One tail t-test. Not all the assumptions of regression analysis are met in the case of dummy variable analysis, and significance tests should be interpretted with caution. However the magnitude of the differences in assessment levels between better practice projects and other projects together with the evidence provided by the significance tests supports the hypothesis that more market assessment is undertaken in projects identified by these four criteria of better practice.

practice (in dummy variable form)[14] in individual analyses. Table 7.8 presents the results of both linear and dummy variable analyses, as well as the coefficients of the resulting relationships.

The regression equation which predicts the level of assessment for a project which meets all four criteria of better practice revealed that the amount of market assessment in such projects is 9.9 times the level in the average project, and 14.0 times the level in poorer practice projects. However, of the 118 projects studied, only three projects were rated as better practice on all four dimensions, and therefore these predicted values are merely mathematical extrapolations.

7.4.2 Discussion of Results

The existence of positive relationships between the four criteria of better practice and the amount of market assessment conducted (for equivalent new product situations) was expected, but the magnitude of the differences was quite surprising. If these four criteria are accepted as reasonable measures of better practice, then better practice projects were clearly associated with substantially higher levels of assessment (from 1.6 to 3.5 times as much as average projects, depending on the measure of better practice).

Both input criteria of better practice (very large firms, and firms employing one or more market assessors) may not be valid criteria to identify better practice projects. For example, a firm which employs a market assessor may undertake market assessment merely to justify the existence of such an employee, or possibly because the employee might be otherwise idle. Similarly, a firm's size is no assurance of normative

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[14]The dummy variable equals unity for better practice, and zero for other projects in each case.

TABLE 7.8

REGRESSION ANALYSIS RESULTS: RESIDUAL MA AND BETTER PRACTICE CRITERIA

Type of Analysis	Better Practice Measure	Significance*	Regression Constant	Regression Coefficient
linear	sales of firm ($000)	.05	-.09164	.0160
linear	number of market assessors	.05	-.09597	.08223
linear	managerial rating of new product program (1-5)	not significant		
dummy variable	very large firms (sales ≥ $100 million)	.001	-.15985	1.23709
dummy variable	one or more market assessors	.025	-.14120	.65422
dummy variable	satisfactory error reduction	.06	-.22829	.48082
dummy variable	new product program rated extremely successful	.05	-.06748	1.09384

*-One tail t-test. Significance tests in the case of dummy variables should be interpretted with caution, as not all the assumptions of regression analysis are met when dummy variables are used.

practices. Nevertheless, the resources, skills, capabilities and experience of such firms suggest that they do provide a useful standard for comparison.

A criterion of better practice which is closely linked to market assessment is the degree of error reduction in market estimates. Firms which were able to at least halve their initial errors in key market estimates during the development phase, did almost twice as much assessment as other firms, which clearly indicated that market assessment had measurable and substantial benefits in industrial new product development. A second output criteria of better practice, although less directly linked to amount of market assessment, is the rated success of firms' new product development programs. While the measure was a self-rating and therefore was possibly biased by various factors including dissonance reduction, firms with "extremely successful" new product programs tended to conduct three times as much assessment as other firms. The prescriptive implications of these findings are presented in the next chapter.

7.5 SUMMARY OF FINDINGS

The empirical results revealed that six of the hypotheses in the first set (H_1) were supported, while a seventh variable was significantly related to amount of assessment, but not in the hypothesized direction. As well, these regression findings were supported by the results using other analytical techniques. Of the nine hypothesized variables which were found not directly related to the amount of assessment, eight appeared to play an important role in the network of relationships of the Behavioral Model. The best fit equation was found to be multiplicative, and explained 40% of the variance in amount of assessment. The four criteria of better practice were clearly positively related to the amount of assessment, thereby supporting the second set of hypotheses, H_2.

CHAPTER VIII

SUMMARY AND IMPLICATIONS

8.1 INTRODUCTION

This final chapter consists of three main sections. The first presents a summary of the research, and its conclusions. The second section reports the practical implications of the research for management and for public policy. The final section suggests related topics for further research.

8.2 RESEARCH SUMMARY AND CONCLUSIONS

This research concerns the amount of market assessment which managers undertake during the development of new industrial products. The main objectives were to determine the amount of market assessment undertaken in industrial new product projects, to identify those factors which influenced the amount of assessment, and to develop a model describing the way in which managers decide on market assessment expenditures. A further aim was the development of a prescriptive guide based on the study of better practice projects.

A hypothesized descriptive model – the Behavioral Model – postulated that the amount of assessment undertaken in a new product project was related to variables which describe the new product situation. The empirical tests of the model were based on data obtained by investigating 118 successful new products developed by Canadian industrial goods firms.

The hypothesized Behavioral Model of information purchasing developed for

this research was supported in part by the empirical findings. The results suggest that, in spite of large individual differences between firms and managers, overall, managers respond to new product situations in a somewhat predictable manner. Much of what is called "intuition" in decision-making can be explicated in a quantitative manner, and the best fit model expression explained 40 per cent of the variance in managers' market assessment expenditures.

The main determinants and the critical dimensions of the market assessment expenditure decision were identified. Seven hypothesized predictor variables – Possible Cost of Failure, Anticipated Annual Product Sales, Payback Period, Product Newness, Purchase Importance, Number of Customers, and Number of Market Segments – appeared to influence the assessment expenditures, six of these in the hypothesized directions. These determinants of the amount of market information managers purchase during the development process, describe the three major constructs of the proposed model – the amounts at stake, the uncertainties and probabilities of the situation, and the cost of market information. Of these three constructs, the amounts at stake were the most important, perhaps because they were the most evident and tangible characteristics of a new product situation, or perhaps, as suggested in a normative analysis and other descriptive research, they had the strongest direct link to the amount of information purchasing. Variables describing the uncertainties and probabilities had a limited effect, while variables proporting to describe the cost of search were more influential than anticipated, in spite of the relatively small expenditures on market assessment. The information acquisition model, in general form, may be applicable to studies in other fields where the research topic concerns information purchasing by decision-makers.

Certainly the decision behavior of managers was not exactly as predicted by the set of hypotheses derived from the Behavioral Model. Of the sixteen hypothesized predictor variables, nine were not significantly and directly linked to the amount of

market assessment undertaken. At first glance, it appears that managers may be resorting to simplified decision strategies: facing a complex decision situation, in order to reduce the cognitive strain, they ignore relevant information and focus on only a few of the more obvious and tangible characteristics of the situation. However, a more complete understanding of the network which exists between variables describing the new product situation, reveals a very complex model of effects: most of the variables which characterize a new product setting do play a role in the model, even though they do not directly influence the decision to undertake market assessment.

With several important exceptions, overall, managers' information purchasing behavior appeared qualitatively consistent with the normative ideal. This does not suggest that the amount of assessment they conducted was even close to the normative amount, but merely that when the situation called for more assessment, managers responded and on average did more assessment. One possible exception concerns managers' perceptions of the cost of market information. That managers undertook less market assessment in the case of products very new to the market suggests that psychological factors may have clouded rational decision-making. One explanation is that generally managers lacked the skills and experience in all but the simplest forms of market assessment, and tended to avoid undertaking unknown and unfamiliar activities. Managers' inabilities to translate many variables describing uncertainties and probabilities into needed action reveals that either they were unaware of the risky situations they faced, or that they tended to ignore the less tangible inputs to the assessment expenditure decision.

There is little question that more normative amounts of assessment may be equated to doing more market assessment. Contrary to the findings of a number of experimental studies, the average manager apparently underbuys market information. The four measures of better practice were all positively related to higher levels of

market assessment: for equivalent new product situations, more market assessment was conducted in projects:

- undertaken in very large firms;
- undertaken in firms employing at least one market assessor;
- where initial errors in market estimates were substantially reduced during the development process;
- undertaken in firms with extremely successful new product programs.

While no one measure is a perfect gauge of better practice, when the measures are considered together, the evidence is more convincing. A method of measuring the payoffs from new product market assessment – the amount of error reduction – was demonstrated to be operational. The empirical evidence that more market assessment results in greater reduction of errors in critical estimates during the development of new products reveals that a greater marketing orientation (measured by the resources committed to market assessment) is vital to effective new product decision-making.

This research has also developed a methodological foundation for future studies into new product development. It has demonstrated that models borrowed or modified from other disciplines can be applied to the new product setting in order to structure the complexities of the situation, and to formulate testable hypotheses. Moreover, the important dimensions which characterize a new product situation have been identified, and operational methods of measuring variables on each dimension have been proposed. Finally the network of effects between variables which describe the new product situation provides other researchers with a much better understanding of the structure of a new product setting, and illustrates the types of interrelationships they might expect in undertaking empirical research in the area.

8.3 IMPLICATIONS TO THE MANAGEMENT OF TECHNOLOGICAL INNOVATION

In this section, the major implications of this research to both business managers and public policy formulators are outlined. These implications, while based on the empirical findings, are somewhat speculative, and were also influenced by informal discussions with managers during the data collection phase of the research.

Successfully undertaken, the development of new and improved products is a particularly lucrative endeavor for industrial products firms. Considering the sample of successful product developments of this research, on average, for each dollar gambled on new product projects (which would have been lost in the event of failure) $18.45 in annual sales to the firm were generated and $5.47 in annual profits resulted. When profits were discounted into the future at 15%, each risk dollar yielded returns of $29.60.

In spite of the evidence that market knowledge is vital to successful new product development, market assessment expenditures played a relatively minor role in the development process when compared to the total amounts at stake. In half the projects studied, market assessment expenditures accounted for less than 2.53% of the total possible downside losses, and less than 2.02% of the expected annual profits derived from the product. Managers' reluctance to spend more than token amounts on market assessment clearly demonstrates why the major causes of industrial new product failures stem from a lack of market knowledge.

The evidence of this research points to the need for more market assessment during the new product development process. If one goal is to improve the accuracy of estimates about key market factors (such as determining what the desired characteristics of the product should be, and estimating accurate sales volumes), then more market assessment appears to be an answer. On average, firms which reduced initial

errors substantially in these market estimates, undertook almost twice as much market assessment during new product projects as firms who failed to reduce these errors, when faced with equivalent new product situations. Moreover, firms which believed their new product programs to be extremely successful tended to conduct much greater amounts of market assessment – over three times as much in individual product developments when faced with equivalent situations – as did other firms. Very large firms, which are expected to be more experienced and capable in new product development, undertook four times as much assessment as smaller firms, when faced with equivalent new product situations. Firms which employed the necessary personnel to do market assessment (and are more likely to undertake market assessment when desirable) conducted over twice as much assessment as firms lacking this personnel, again when faced with equivalent new product situations. The research evidence above reveals that clearly the average project was characterized by far too little market assessment, indicating that many firms have not adopted a sufficient market orientation in their new product development activities.

Managers' reluctance to undertake market assessment, even though the benefits are increasingly evident, appears to stem more from the lack of necessary skills and experience and a tendency to avoid the unfamiliar, than from its high financial cost. Even in better practice projects, the cost of market assessment represents only a small proportion of the total amounts at stake. Highly innovative products (new to the market), where market uncertainties are logically expected to be very great, actually had less market assessment undertaken during their developments than less innovative products, when all other considerations were equal. Evidently, the difficult nature of the assessment task in the case of totally new products overshadows the value of good market information. In projects in general, the usual constraints of a lack of time and a lack of customer cooperation were not decisive factors in determining how much

assessment was done in new product ventures. Finally, those firms which lacked the needed personnel undertook much less assessment in equivalent projects, clearly demonstrating that the lack of skills and capabilities severely constrained their market assessment activities.

Obtaining good market information, while a challenging task, particularly in the case of highly innovative products, is not an impossible task. To enjoy the benefits market assessment can provide at a moderate cost, clearly the market assessment skills and resources of many firms need to be improved.

One aim of the research focussed on the development of a prescriptive guide for managers. The Average Manager Model – the best fit descriptive equation derived in Chapter VII – provides useful standards for comparison when deciding how much to spend on market assessment. This mathematical relationship reveals how much market assessment managers undertook when faced with various types of new product projects. The assessment expenditure practices of managers, on average, are shown in graphical form in Figure 8.1. If a manager can characterize his own new product situation on each of the seven dimensions outlined in figure 8.1, by using the set of curves provided, he can predict approximately how many manhours the average manager in the sample of this research would have devoted to market assessment activities during the project.

The prescriptive utility of the Average Manager Model can be improved by several modifications. First, the Average Manager Model is not a model of the best practice. In fact, better practice projects were characterized by 1.6 to 3.5 times as much assessment, depending on how "better practice" was measured. (When all four measures of better practice were considered together, the better practice project was characterized by over nine times as much assessment. However this result is an extrapolation and must be used with caution). Multiplying the result obtained from the

KEY:

The Average Manager Model is shown in curve form in figures 8.1.a. to 8.1.g. These curves are based on the best fit multiplicative regression equation, equation (7.1). The expected assessment expenditive is determined graphically by multiplying the value obtained from the ordinate axis in figure 8.1.a. by each of the multiplier values from ordinate axes in figures 8.1.b. to 8.1.g. Operational definitions of variables in figure 8.1 are given in Appendix B.

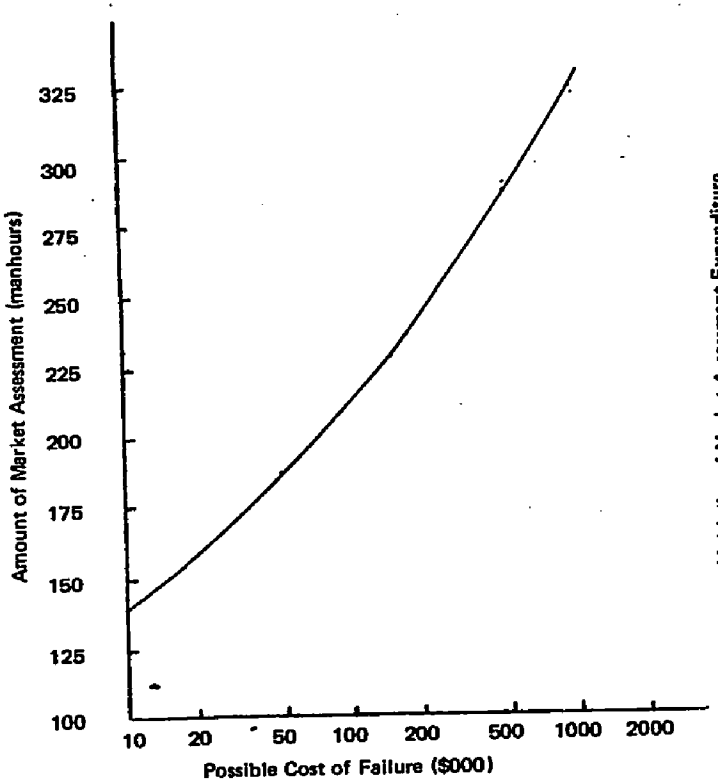


Figure 8.1.a. Determinants of Market Assessment Expenditures: Possible Cost of Failure

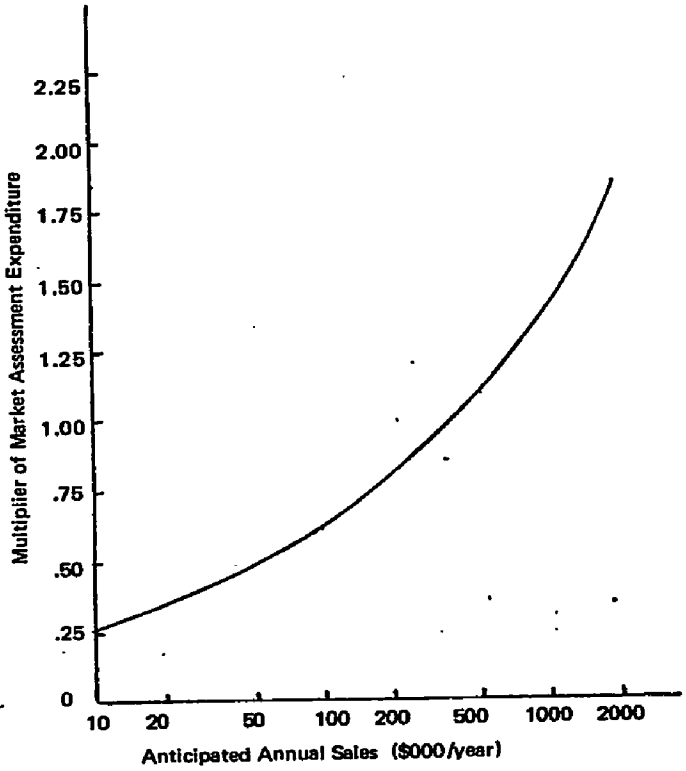
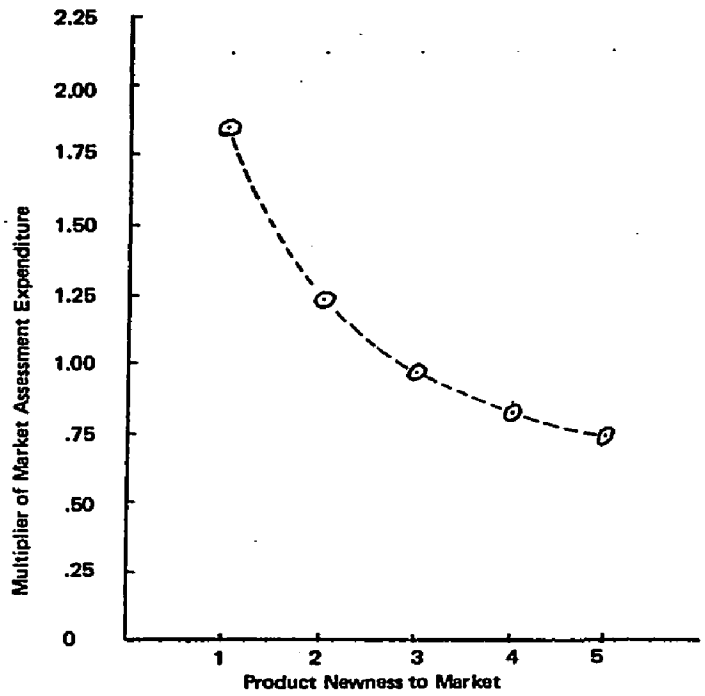


Figure 8.2.b. Determinants of Market Assessment Expenditures: Anticipated Annual Product Sales



KEY:
Product Newness Code:
The product is:
Virtually identical to products on the market = 1
Fairly similar to products on the market = 2
Moderately similar to products on the market = 3
Only slightly similar to products on the market = 4
Not at all similar to products on the market = 5

Market Segments Code:
Potential customers are:
All in a single industry = 1
Mostly in a single industry = 2
In a few different industries = 3
In several different industries = 4
In many different industries = 5

Dotted lines indicate predictor variable is not continuous.

Figure 8.1.c. Determinants of Market Assessment Expenditures: Product Newness

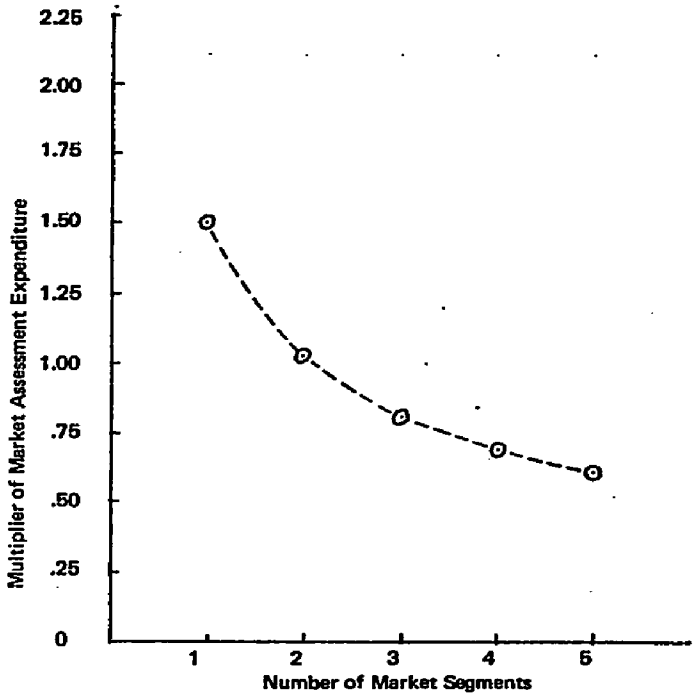


Figure 8.1.d. Determinants of Market Assessment Expenditures: Number of Market Segments

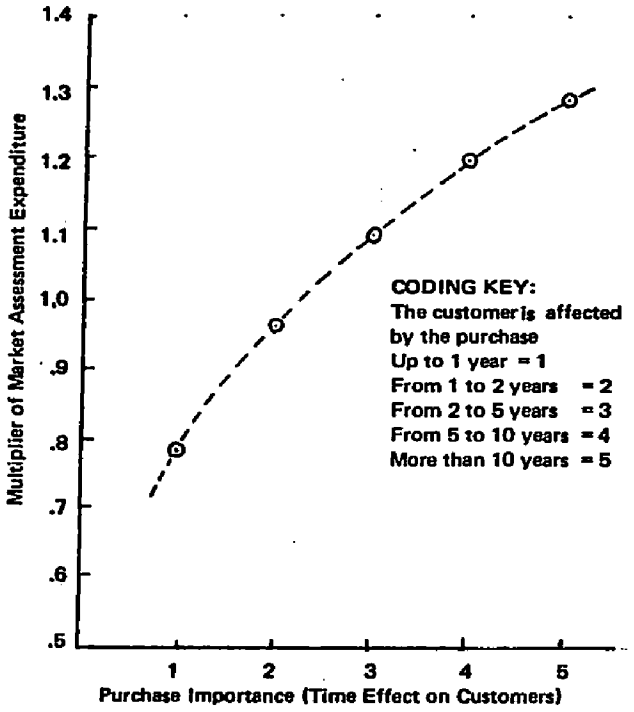


Figure 8.1.e. Determinants of Market. Assessment Expenditures: Purchase Importance.

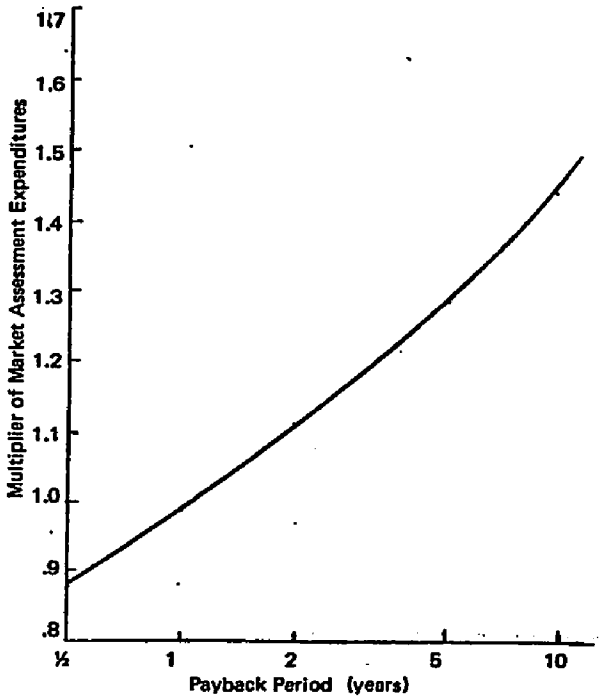


Figure 8.1.f. Determinants of Market Assessment Expenditures; Payback Period.

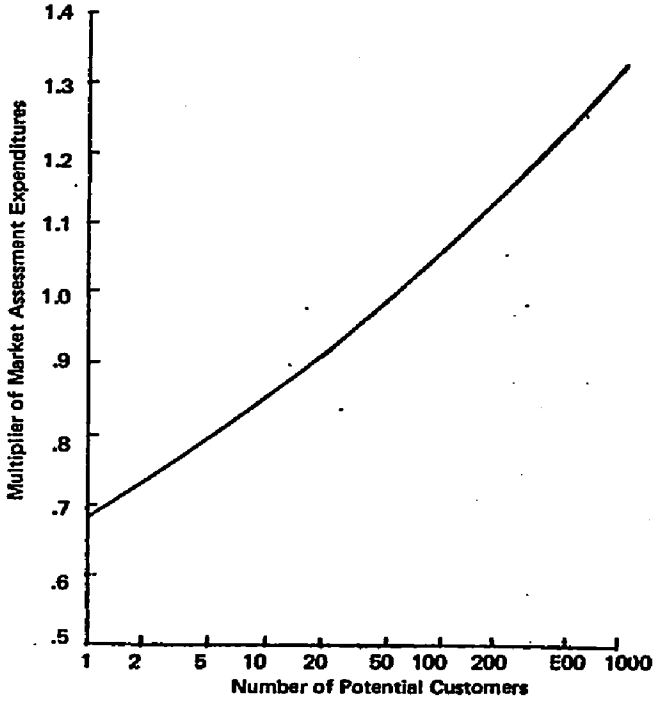


Figure 8.1.g. Determinants of Market Assessment Expenditures: Number of Potentir, Customers.

Average Manager Model by 1.6 to 3.5 yields a range of better practice standards. Secondly, managers tended to conduct less assessment in the case of highly innovative products, a result which differs from the normative expectation. Therefore, in calculating the typical assessment expenditure for a given new project, a low Product Newness (PN=1) should be used. The resulting expenditure then represents the minimum man-hours of assessment – the figure for products which are "virtually identical to products on the market". If a more innovative product is considered, the manager should be prepared to spend more on assessment than this minimum figure.

Successful technological innovations, considered individually and in aggregate, are a vital concern to public policy formulators. The abilities of business managers to successfully undertake new product ventures affect the health and stability of the nation's economy, influence future expenditures on R & D, and also determine the success or failure of government science and technology policies and programs. The implications of this research to business managers become the serious concern of government policy formulators as well.

Spending more on market assessment may be just as important as increased R & D efforts in order to achieve higher levels of successful new product development. Given the relative magnitudes of expenditures in each area, given the main causes of new product failure, and given the added benefits of small increases in market assessment expenditures, the marginal returns from market assessment expenditures may well outweigh the marginal returns from more R & D. Government incentive and assistance programs should recognize and emphasize the importance of conducting market assessment to complement the R & D effort. One encouraging development in Canada is that marketing research activities can now be subsidized by Federal Government assistance programs in the same way R & D efforts have been. Whether or not a significant number of firms will take advantage of this assistance may not be known for some time.

Federal Government policies in technological innovation assistance might also persue one or all of the following courses of action:

1. education of managers: It appears that many managers and firms are either unaware of the benefits of market assessment, or do not know how to acquire reliable market information. Various communication devices aimed at business management, such as promotional literature, publications, and government sponsored refresher courses, could create both an awareness of the need for market assessment in new product development, and a knowledge of the techniques of industrial marketing research.

2. financial assistance: Besides providing financial assistance to firms to undertake market assessment, technical incentive programs might require that market assessment be undertaken as an integral part of every government subsidized new product venture. The marketing research should be conducted by a competent team within the company, or by professional and experienced outside groups.

3. consulting assistance: The possibility of educating government technical field officers in the use of market assessment during new product development, and providing government market consulting services to industry at a nominal charge should be considered.

8.4 FUTURE RESEARCH

While the present research provided an insight into issues concerning new product development and market assessment, it also raised a number of further research

questions. Suggestions for future research concern refinements to the present study and new questions raised by the research.

1. refinements to the study: Further research should attempt to develop a decision model which more clearly identifies and explains the decision process to undertake market assessment. The present research concerned general relationships between new product situational variables and amount of assessment -- a type of macro model. A more complete understanding of the decision process would be gained by focussing on the particular decision and particular set of circumstances considered in each new product situation. The result may be a decision tree model -- a conditional model -- which indicates why and how managers consider various situational characteristics depending on the new product setting. Such a study may also identify characteristics of managers and organizations which influence the search decision.

A second refinement concerns the direct measurement of the constructs of the hypothesized model for the present research. The present study employed these constructs -- amounts at stake, uncertainties and probabilities, and cost of information -- to identify more concrete variables and to derive testable hypotheses. However, the way in which managers actually see these constructs -- for example, the amounts at stake -- was never determined, nor were direct measures of the constructs obtained.

The third area of refinement involves the development of improved criteria of better practice. The four criteria of better practice employed in this research represent an initial attempt to rank companies and projects. However, a number of other measures might be proposed, and techniques such as factor analysis and discriminant analysis might be used to derive a composite index of better practice.

2. new research questions: A logical step from the present research is the investigation of the qualitative nature of market assessment activities undertaken in

new product ventures. The present study focussed on only one dimension of assessment activities – the amount of assessment. An understanding of the types of market assessment activities firms undertake might prove equally enlightening. Certainly such a study would reveal the strengths and weaknesses of current practice, and would outline the problems managers face in acquiring good market information. Much of this data has already been gathered, and exists in the form of summaries of case studies of new product development activities.[1] What is now required is the development of a model or classification scheme to structure this wealth of information and to present it in some meaningful fashion.

A second research question concerns the approaches and practices which firms should employ in conducting effective industrial new product market assessment. One of the conclusions of the present research points to the lack of market assessment skills and knowledge possessed by many firms in the sample. However during the course of the data collection phase, a limited number of projects were investigated where the calibre of market assessment appeared to the interviewers to be unusually high. A written description of the assessment activities in such projects would provide a valuable guide to other managers and firms, and may suggest a number of approaches, concepts and practices which could improve their own new product market assessment activities.

The underlying objective of the research was to contribute to the improvement of the new product development process by focussing on the role of new product market assessment. To the extent the research provided an insight into present practice, created an awareness of the need for more and better market assessment, and defined new areas for research, this objective was met.

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[1]This data constitutes part of the existing data bank employed in the present research.

APPENDIX A

AN ALGEBRAIC RELATIONSHIP FOR THE OPTIMAL COST OF SEARCH

A.1 INTRODUCTION

The purpose of this appendix is to outline the derivation of an algebraic expression which relates the optimal cost of search to the relevant probabilities, consequences, and costs of a Bayesian choice problem. The optimal search level occurs when the marginal value of information (MEVI) equals the marginal cost of search (MCS). Therefore this appendix begins by developing an algebraic expression for the MEVI, using a simple "single alternative" and later an "n alternatives" representation of the Normative Model in Chapter II.

A.2 DERIVATION OF THE MEVI EXPRESSION (Single Alternative Choice Model)

The decision model used in this derivation of the MEVI expression is the Normative Model developed in Chapter II, Section 2.4 for the analysis of market assessment decisions in new product development. The "single alternatives" choice model represents the situation where n = 1 and the decision-maker has the choice of introducing the product or abandoning the project. (The "n alternatives" choice problem presents the case where n alternative product sets are considered for introduction, plus the alternative of not introducing the product at all).

Before proceeding with the derivation, a definition of Search Accuracy – a measure of the level of search – is required. Search Accuracy is defined as "the probability that the search portrays the world the way the world really is." For example, if the world is such that product set Z is highly desired, and would be successful if introduced, then Search Accuracy is the probability that the search indicates that Z is desired and would be a success:

$$\text{Search Accuracy} = A = P(S=Z \mid Z) \tag{A.1}$$

The same search has another possible outcome: that product set Z is not desired, and would fail if introduced. The Search Accuracy then becomes the probability that the search reflects this situation:

$$A = P(S \neq Z \mid \text{not } Z) \tag{A.2}$$

In this derivation, the various accuracies of a given search will be assumed to be the same; that is, Accuracy is the probability that the search results are truthful, regardless of the outcome of the search.

The Normative Model of Chapter II defines the Expected Value of Search Information (EVSI) for various search accuracies as the difference between the Expected Value with Search (EVS) and Expected Value with No Search (EVNS). The Expected Value with No Search (EVNS) is independent of search level, and is therefore a constant with respect to Search Accuracy. Therefore the slope of the EVSI curve equals the slope of the EVS curve when plotted against A:

$$EVSI = EVS - EVNS \tag{2.2}$$

$$\frac{d(EVSI)}{dA} = \frac{d(EVS)}{dA} - \frac{d(EVNS)}{dA} \tag{A.3}$$

$$MEVI = \frac{d(EVSI)}{dA} = \frac{d(EVS)}{dA} \tag{A.4}$$

This derivation will focus on the EVS, since its mathematical relationships are less complex than the EVSI.

Figure A.1 summarizes a single alternative choice decision tree, where product Z is being considered for introduction. If the product is introduced, two outcomes are possible: success and failure. The consequences of these outcomes are:

R = payoffs or rewards if the product is a success;

F = cost of failure of the product.

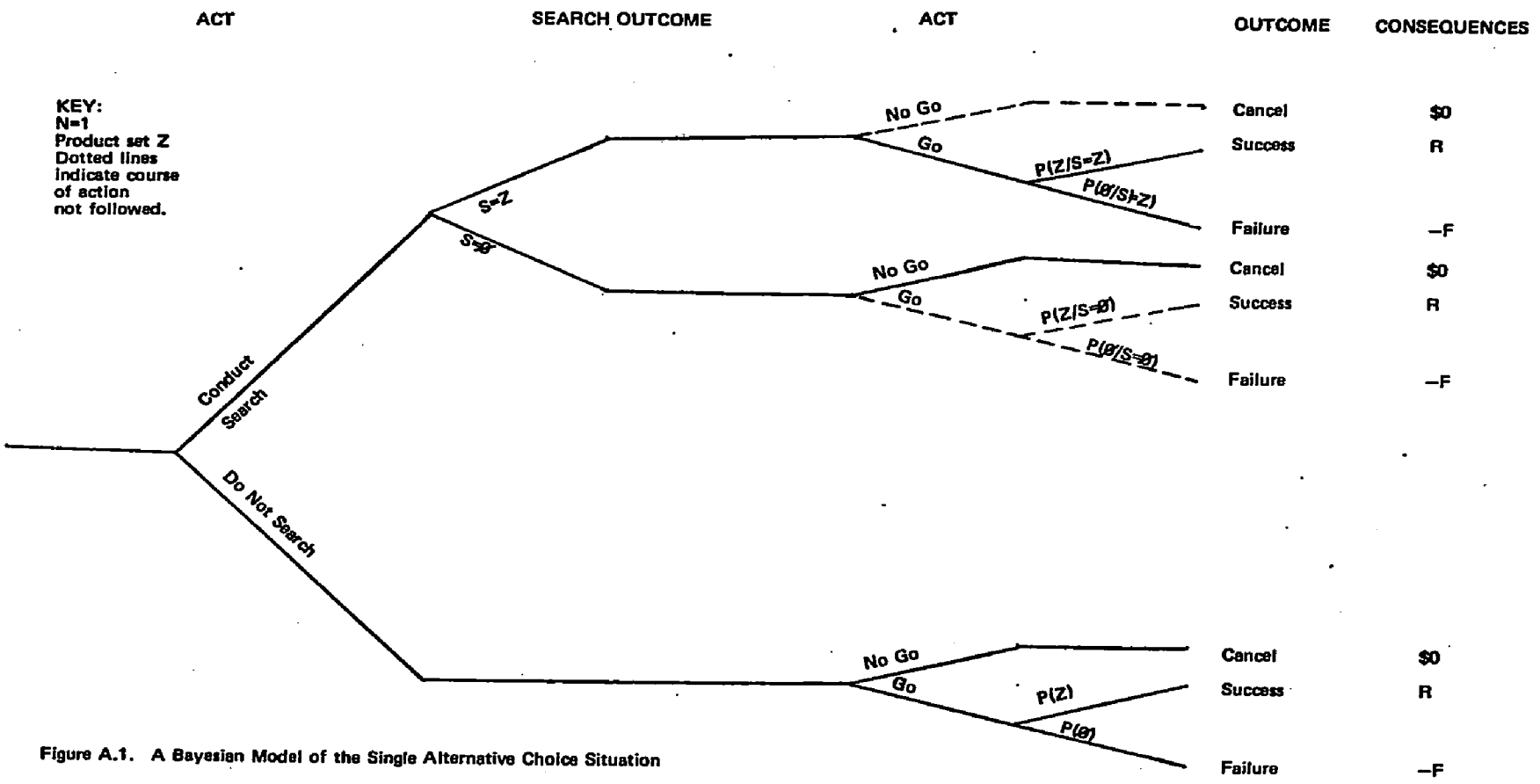

Figure A.1. A Bayesian Model of the Single Alternative Choice Situation

If search is undertaken, two search outcomes are possible: the search may indicate that product Z will be successful (S=Z) or will not be successful (S=ϕ). The accuracy of the search can be written as a joint probability, as follows:

$$A = P\,(S=Z \mid Z) = \frac{P(S=Z \cap Z)}{P(Z)} \quad \text{(A.5a)}$$

An inaccurate search would be represented by the following expression:

$$1-A = P\,(S=Z \mid \phi) = \frac{P(S=Z \cap \phi)}{P(\phi)} \quad \text{(A.5b)}$$

Both these equations can be transposed to yield the following expressions for the joint probability terms:

$$P(S=Z \cap Z) = A.P(Z) \quad \text{(A.6a)}$$

and

$$P(S=Z \cap \phi) = (1-A).P(\phi) \quad \text{(A.6b)}$$

If the decision to introduce the new product is made according to the search outcome[2] (that is, if S=Z, then Z would be introduced), then by tracing the "GO" arm of the SEARCH S=Z branch of the decision tree in figure A.1, the EVS can be written as:

$$EVS = [P(Z \mid S=Z).R - P(\phi \mid S=Z).F].P(S=Z) \quad \text{(A.7)}$$

Note that if the search indicated Z was not desired (S=ϕ), then the product would not

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[1]The symbol $\cap$ denotes joint probability or intersection.

[2]This assumes a reasonable search accuracy and that R and F are of the same order of magnitude. Both assumptions are congruent with the likely conditions of a new product situation.

be introduced, and therefore the expected value of the S=ϕ branch is zero.

The probability terms within the square parenthesis of the EVS expression (equation A.7) can be rewritten in terms of a joint probability, as follows:

$$P(Z|S=Z) = \frac{P(Z \cap S=Z)}{P(S=Z)} \qquad (A.8a)$$

$$P(\phi|S=Z) = \frac{P(\phi \cap S=Z)}{P(S=Z)} \qquad (A.8b)$$

Substituting these equations (A.8) in the EVS expression (equation A.7) simplifies the EVS expression to:

$$EVS = R.P(Z \cap S=Z) - F.P(\phi \cap S=Z) \qquad (A.9)$$

Substituting the joint probability expressions derived from the search accuracy terms (equations A.6a & b) into the EVS equation (A.9) yields:

$$EVS = R.P(Z).A - F.P(\phi).(1-A) \qquad (A.10)$$

Noting that $P(\phi)$ = 1-P(Z) and abbreviating the term P(Z) to P, then equation (A.10) can be rewritten:

$$EVS = R.P.A. - F.(1-P) . (1-A) \qquad (A.11)$$

where P is the prior probability of Z being successful, P(Z).

The derivative of the EVS with respect to A equals the MEVI; differentiating equation (A.11) with respect to A yields:

$$MEVI = RP + F.(1-P) \qquad (A.12)$$

Several conclusions can be drawn from this relationship for the single alternative choice problem:

1. Increasing the rewards, R, increases the MEVI.
2. Increasing the cost of failure, F, increases the MEVI.
3. Increasing the prior probability of success, P, will increase the MEVI, provided R> F (which is the case for most new product developments).

A.3 DERIVATION OF THE MEVI RELATIONSHIP (N-ALTERNATIVE CHOICE MODEL)

In Chapter II, Section 2.4, it was pointed out that the two action model frequently used in the describing choice problems, does not reasonably describe the true situation faced in a new product development.

The situation where n alternate product sets[3] are considered is presented in figure A.2 for n=3 (product sets W, Y and Z). Assume that the success of each product set is mutually exclusive, that is, if Y is a success Z and W cannot be successful. Four search outcomes are possible, with the search indicating that each of the three product sets will be successful, or that none will be, ($S=\phi$).

For ease of mathematical representation, let the prior probabilities of success of each of the n alternatives be the same, designated by P. Thus P can be thought of as "the level of priors" on success. In addition, the consequences, R and F, will be assumed to be the same for each of the n alternatives.

Consider a single search outcome: for example, the search outcome which indicates that Z will be successful, S=Z.

If it is assumed (as in the single alternate case) that the search outcome

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[3]As described in Section 2.4, for each new product project, a number of "product sets" or possible product alternatives exist. For example, these alternatives may be described in terms of price, product characteristics, and other dimensions of the marketing mix.

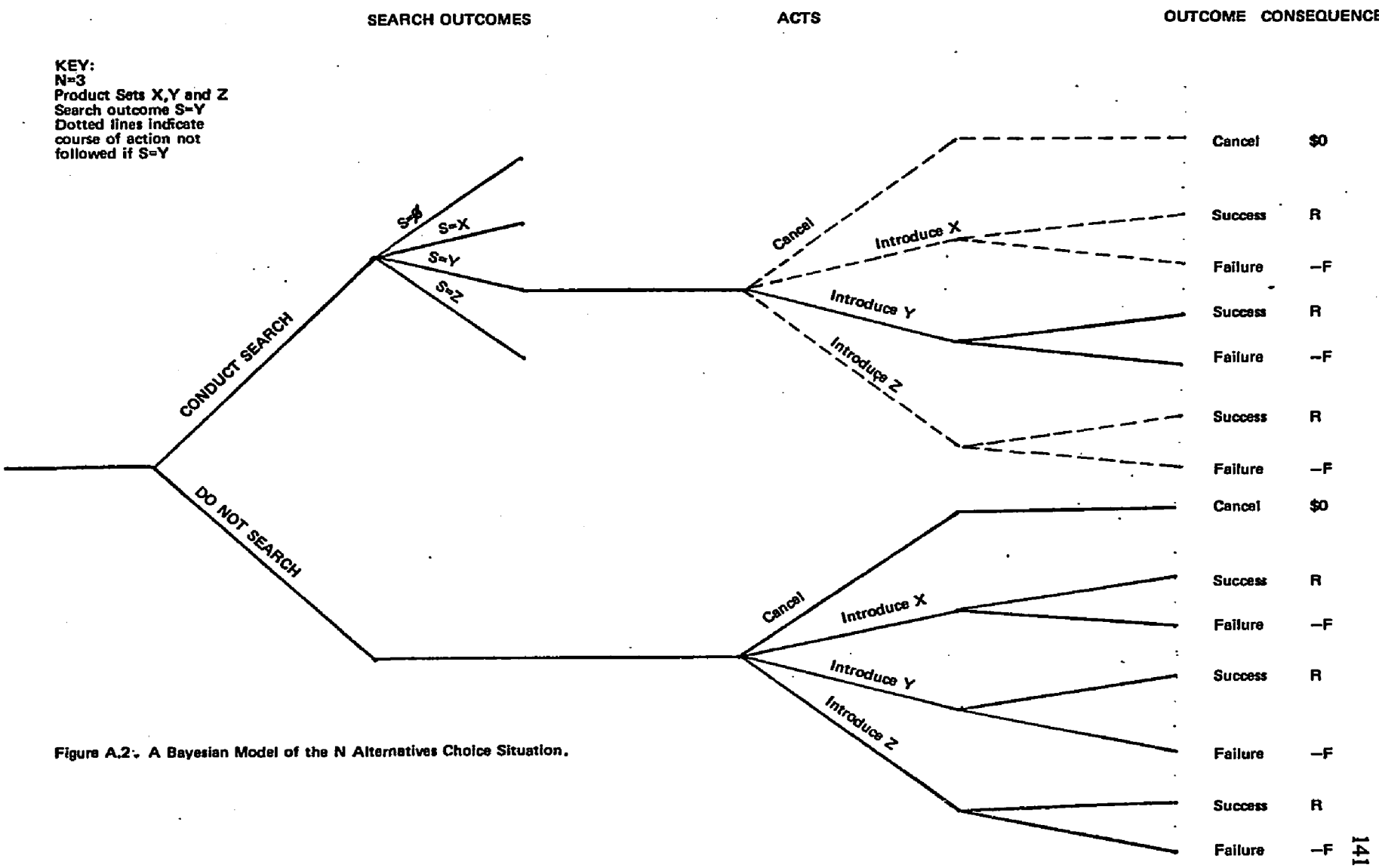

Figure A.2. A Bayesian Model of the N Alternatives Choice Situation.

determines the action to be taken, then if S=Z, product Z will be introduced. The expected value of the search outcome S=Z can be determined as in the single alternate case:

$$E(S=Z) = [P(Z|S=Z) \cdot R - F \cdot \{P(W|S=Z) + P(Y|S=Z) + P(\phi|S=Z)\}] \cdot P(S=Z) \quad (A.13)$$

If it is assumed that in the case of an inaccurate search, the probability of a search outcome occurring is independent of the particular state of nature, that is that:

$$P(S=Z|W) = P(S=Z|Y) = P(S=Z|\phi) = \frac{1-A}{n} \quad (A.14)$$

then following the same sequence of transformations and substitutions as in the single alternate case, equation (A.13) can be rewritten as:

$$E(S=Z) = RPA - F\left[\frac{(n-1) \cdot (1-A)P}{n} + \frac{(1-A) \cdot (1-nP)}{n}\right] \quad (A.15)$$

where $P = P(Z) = p(W) = P(Y)$.

This relationship (A.15) simplifies to:

$$E(S=Z) = -RPA - \frac{F}{n} \cdot (1-A) \cdot (1-P) \quad (A.16)$$

Note that the expected value with search (EVS) is the sum of the expected values of the n+1 search outcome branches:

$$EVS = E(S=Z) + E(S=Y) + E(S=W) + E(S=\phi) \quad (A.17)$$

Again the value of $E(S=\phi)$ is zero, while the other expected value terms are all equal. Then the EVS can be written as:

$$EVS = nPRA - F \cdot (1-A) \cdot (1-P) \quad (A.18)$$

Differentiating equation (A.18) with respect to A yields an expression for the MEVI, which is similar to that developed for the single alternative case:

$$MEVI = nPR + F \,.\, (1\text{-}P) \qquad (A.19)$$

A most useful result of this derivation is quickly apparent: the curve of EVS plotted against A is a straight line. This result is convenient, since the slope of the EVS or the MEVI can be described by a single value, instead of by some function of A.

A.4 DETERMINATION OF THE OPTIMAL COST OF SEARCH

In Chapter II, Section 2.4, the Cost of Search was shown to increase with the Search Accuracy, A, and therefore may be written as:

$$CS = g.f(A) \qquad (A.20)$$

where g is a cost of search parameter. Shifts in the cost curve are reflected by changes in the parameter g, while changes in the shape of the curve yield a change in the function, f(A). Movements along the curve in figure 2.4 (Chapter II) reflect variations in the accuracy A, and hence in the value of f(A).

Several possible functional relationships may be proposed to describe f(A). A review of the probably shape of the CS curve suggests three likely functional forms:

1. logarithmic: $\ln CS = r.\ln A + \ln g \qquad (A.21a)$

   or more simply:

   $CS = gA^r \qquad (A.21b)$

2. semi-logarithmic: $CS = G.\ln \frac{1}{1-A} \qquad (A.22a)$

   or $A = 1\text{-}e^{-CS/g}$

3. exponential: $CS = ge^{rA}$ (A.23)

where g and r are parameters;
ln means natural logarithm;
e is exponential e.

To determine which of the proposed CS functions appears most reasonable, each of these expressions was compared to an actual cost of search curve. In a simple example, if it is assumed that:

- CS is proportional to sample size;
- $\sigma_{\bar{x}}$, the standard deviation of the sample mean, is related to the inverse of the square root sample size:

$$\sigma_{\bar{x}} = \frac{\sigma_x}{\sqrt{N}};$$

- and $\sigma_{\bar{x}}$ is related to the accuracy A, where $A = P(S=X|X)$, via a normal curve;

then relative values of CS can be determined for corresponding values of A.

When the three proposed functional relationships were fitted to these CS and A values, it was found that the logarithmic expression yielded too shallow a curve, the semi-logarithmic curve was too dished, while the exponential function provided a reasonably good fit. For values of A between 0.30 and 0.90, the maximum error in the exponential expression was 3%, increasing to 9% when A = .95. Therefore, in the derivation of an optimal search expression, the general form of the CS function will be assumed to be:

$$CS = ge^{rA} \quad \text{(A.23)}$$

where both g and r are positive.

The marginal cost of search, MCS, is determined by taking the first derivative

of CS with respect to A:

$$MCS = \frac{d(CS)}{dA} = rge^{rA} \tag{A.24}$$

The optimal accuracy, A*, is found by equating the marginal values, MEVI and MCS:

$$MCS = MEVI$$

$$rge^{rA^*} = MEVI$$

$$ge^{rA^*} = \frac{MEVI}{r} \tag{A.25}$$

But the cost of the optimal search, CS*, is related to A* by the cost of search expression:

$$CS^* = ge^{rA^*} \tag{A.26}$$

Substituting equation (A.26) in equation (A.25) yields an expression for the optimal cost of search:

$$CS^* = \frac{MEVI}{r} \tag{A.27}$$

Increases in the MEVI, as expected, tend to increase the optimal search cost CS*. Also, if the cost of doing the search increases more rapidly – the exponential rate of increase, or r, is greater – the optimal search cost, CS*, decreases.

The special effect of a limited number of information sources or a limited population size was also investigated. A limited population size changes the shape of the CS curve, with the general result that the value of CS tends to decrease;[4] that is,

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[4]The value of $\sigma_{\bar{x}}$ is multiplied by the factor $\frac{N_{p-N}}{N_{p-1}}$ where Np is the population size, and N the sample size.

a limited population size decreases the optimal search cost, CS*.

If the expression previously derived from the MEVI (equation A.19) is substituted in the CS* relationship, equation (A.27), then the resulting optimal expression in terms of probabilities and outcomes is:

$$CS^* = \frac{nPR + (1-P)F}{r} \qquad (A.28)$$

The individual effects of variables in the optimal cost of search relationship (equation A.28) can be determined by taking partial derivatives of CS* with respect to each variable. Table A.1 gives these parital derivatives and the effects that increases in each variable will have on CS*.

TABLE A.1

PARTIAL DERIVATIVES OF CS* EXPRESSION

Item	Variable	Partial Derivative(Slope)	Effect on CS*
1	R	$\frac{nP}{r}$	positive
2	F	$\frac{1-P}{r}$	positive
3	r	$-\frac{nPR + (1-P)F}{r^2}$	negative
4	P	$\frac{nR-F}{r}$	positive
5	n	$\frac{PR}{r}$	positive
6	n and P together	$\frac{2R - F/n}{r}$	positive
7	n with nP constant	$\frac{F}{n^2 r}$	positive

The choice situation characterized by a broad and shallow prior probability distribution – where the number of alternatives, n, is greater with a corresponding low prior level, P – represents a highly uncertain situation. Therefore, item 7 in Table A.1 above, shows that increasing uncertainty tends to increase the optimal cost of search, a result which was anticipated.

The following normative tenets summarize the effects of individual variables on the optimal cost of search:

1. Increasing R increases CS*.
2. Increasing F increases CS*.
3. Increasing n and P together increases CS*.
4. Increasing n and decreasing P (constant nP) increases CS*.
5. Increasing uncertainty increases CS*.
6. Increasing r decreases CS*.
7. A limited population size or number of information sources decreases CS*.

The parameter r may be interpreted by noting that:

$$CS = ge^{rA} \tag{A.23}$$

$$\text{and} \quad MCS = gre^{rA} \tag{A.26}$$

Dividing equation (A.23) by equation (A.26), and noting that $MCS = \Delta CS/\Delta A$ as $\Delta A \to O$, the following expression is obtained:

$$r = \lim_{\Delta A \to O} \frac{\Delta CS}{CS} \cdot \frac{1}{\Delta A} \tag{A.29}$$

The parameter, r, therefore, is the percent change in the search cost ($\frac{\Delta CS}{CS}$) required to yield a specific increase in accuracy (ΔA), or more simply, the per cent marginal cost of search.

Nomenclature of Appendix A

A	=	Search accuracy.
A*	=	Optimal search accuracy.
CS	=	Cost of Search.
CS*	=	Optimal cost of search.
e	=	Exponential e.
E	=	Expected value.
EVNS	=	Expected value of outcomes with no search.
EVS	=	Expected value of outcomes with search.
EVSI	=	Expected value of search information = EVS-EVNS.
F	=	Possible cost of failure.
g	=	Parameter in cost of search expression.
ln	=	Natural logarithm.
MCS	=	Marginal cost of search.
MEVI	=	Marginal expected value of search information.
n	=	Number of alternative new product choice acts.
P	=	Level of prior probabilities of success.
P(i)	=	Probability of i.
P(Z)	=	Probability that Z will be successful.
r	=	Parameter in cost of search expression.
R	=	Payoffs or rewards, if the product is a success.
S	=	Search.
S=Z	=	the search indicates Z will be successful.
X,Y,Z	=	Product sets.
ϕ	=	No product set successful.

APPENDIX B

OPERATIONAL DEFINITIONS OF VARIABLES AND DESCRIPTION OF THE SAMPLE

Empirical data for the study, which existed in the form of a data bank, were obtained during two personal interviews with managers as well as with a mailed questionnaire.[1] The main variable of the study, the amount of market assessment conducted in a new product project, is conceptually defined as the total effort spent on activities involved in gathering market information during the development of the product. Both formal efforts (such as market research studies and statistical analysis of data) and informal activities (such as personal visits, salesmen visitation and field protype tests) were included in the definition. All variables which characterize the new product situation were defined as being perceived by the manager near the beginning of the development of the product.

B.1 MEASURES OBTAINED DURING THE FIRST INTERVIEW

During a two to four hour interview, which was based on a lengthy printed questionnaire, managers were asked to relate a case history of the development of a successful new product. Following this discussion, the following measures were obtained:

B.1.1 Amount of Market Assessment, MA

> Now I would like to go into some detail on this specific new product. In particular, I would like to look at your process of gathering market information on the product during its development.
> First, can we look at the extent of market analysis, that is, the effort expended by your company in assessing the market for this particular new product during its development.
>
> a) What market analysis activities did your company do over the entire product development to assess factors concerning the product, such as the product performance requirements, price and potential sales volume? Can

[1] A description of the sample of firms is provided in Table B.1 at the end of this appendix.

you estimate the manhours spent on these activities over the entire project and when these activities were done?

With a knowledge of the case history which preceeded, the researcher was able to probe the manager, to ensure that all activities involved in the gathering of market information were included. In addition, similar questions were posed to determine the amount of assessment undertaken to determine the way in which individual buyers purchase the product, and also the nature of the adoption process in the market. MA equals the sum of the manhours spent on these activities.

B.1.2 Possible Cost of Failure F[2]

Could you estimate the potential financial loss, if for some reason the product had achieved absolutely no sales? (Include in this estimate all development costs, investment and effects on the company's overall operation) $_____.

B.1.3 Number of Customers, NC[3]

We now wish to discuss the characteristics of the market into which you decided to introduce the product.

What was the number of potential customers for the produce in the market? _____

B.1.4 Annual Sales of the Firm

What are the current annual sales of your company? $_____

(Large autonomous divisions and subsidiaries were treated as separate companies.)

B.1.5 Number of Full Time Market Assessors

Following a description of activities considered to be market assessment activities, the following question was posed:

Do you have any people actively involved full time in market analysis and assessment? If so, how many? _____

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[2]Although the variables, cost of failure and number of customers, were conceptually defined as perceived by managers near the beginning of the development process, no specific time point was mentioned in these two questions. However it is expected that both perceptions are relatively stable over the development phase.

[3]See reference 2.

B.1.6 Reduction in Errors of Market Estimates

The degree to which managers were able to reduce prior errors in estimates of market factors during the development of the product was determined by measuring:

(a) errors in estimates at the beginning of the project, E_o;

(b) changes in estimates between the beginning and commercialization phase of the project, E_c.

Following a definition of both time points, the following questions were posed:

(a) Let us move to the present. I am interested in the situation as it is today and your current beliefs regarding the product. I am also interested in comparing your original beliefs back at the beginning of the project with what you now believe.

In view of what has happened, what are your current beliefs regarding _____? How much as your original idea of _____ at the beginning of the project, changed to date? You may answer using this card.

Factor	Change					Coding
Performance Requirements	____ none	____ very low	____ low	____ consid-able	____ high	(0 to 4) (left to right)
Selling Price	_____ % change ( )					(%)
Quantity (sales volume)	_____ % change ( )					(%)

(b) Imagine that you are now at the point in time just prior to commercialization of the product. At this point you probably had to finalize your ideas regarding the product, and make some decisions based on these ideas. I am interested in what your final beliefs at commercialization were regarding the product and how much your beliefs had changed since the beginning of the project.

At commercialization, what was the company's idea of the _____? How much had the company's beliefs regarding the _____ changed since the beginning of the project? (The manager was presented the same card as in item (a) above.)

The degree of error reduction for each of the three market estimates (performance requirements, price and volume) is the ratio of the two error measures:

$$\text{Error Reduction} = \frac{E_c}{E_o}$$

An error reduction of 1.0 indicates that initial errors in estimates were completely corrected during the development phase, while a score of 0.0 means initial errors remained through to commercialization.

B.2 MEASURES OBTAINED WITH THE MAILED QUESTIONNAIRE

The mailed questionnaire which was accompanied by an explanatory letter, began with the following preamble:

PRODUCT:_____

We would like you to provide a description of the product situation on a number of characteristics, AS YOU WOULD HAVE DESCRIBED IT JUST PRIOR TO THE FIRST STAGE OF DEVELOPMENT. That is, we would like you to imagine you are considering the product as a possible development project, back in time before any significant time or money had been spent on product development. At that time you would have known less about several aspects of the product than you know now, but you would have had at least some impression about all aspects of the product.

We recognize that there is some difficulty in trying to view the product from a point in the past but our research analysis will take that difficulty into account. So please just assume the "pre-development" view to the best extent possible.

You will notice that the statements each have several alternative phrases to allow different scales of description. The scales require your judgement and interpretation. Even if you are somewhat uncertain of the situation, choose from each scale the phrase that best indicates your impression. In some cases, a numerical estimate is required.

For each statement, check the phrase on the scale (or fill in the estimate) that you think was most appropriate for your "pre-development" point of view.

Nominal data was generally coded from left to right, 1 to 5. Variables denoted by an asterisk were coded 1 to 5, right to left. The classification schemes for continuous variables are also given.

B.2.1 Relative Cost of Failure, RF*

Relative to the average of the new products our company has introduced over the last five years, the maximum potential loss we might face, if this product is totally unsuccessful will be approximately	twice as much as the average product or more	1½ times the average product	the same as average product	¾ of the average product	half the average product or less

B.2.2 Newness of the Product Market to the Firm, MN

The potential customers for this product will be	present customers only	mostly present customers	about equal present and new customers	mostly new customers	new customers only

B.2.3 Product Market Stability, SM*

For this type of product, customer needs (what customers want in the way of a product) will tend to change	not at all	at a low rate	at a moderate rate	at a fairly high rate	at a very high rate

B.2.4 Product Newness to the Market, PN

To the potential customer, this product will likely be seen as	virtually identical to products on the market	fairly similar to products on the market	moderately similar to products on the market	only slightly similar to products on the market	not at all similar to products on the market

B.2.5 Degree of Competition in the New Product Market, DC

The degree of competitiveness our product will face will be	very low	low	moderate	high	very high

B.2.6 Product Newness to the Company, TN

Compared to existing company products, this product will be	a slight modification of an existing company product	a moderate modification of an existing company product	a major modification of an existing company product	for the most part a new product to the company	a completely new product to the company

B.2.7 Product Complexity, PC*

In designing and developing the technical features of our product, there will be	very many technical alternatives	many technical alternatives	a moderate number of technical alternatives	few technical alternatives	only one technical alternative

B.2.8 Purchase Task Newness, PTN

In buying this product, the typical potential customer will face	a completely familiar buying task	a fairly familiar buying task	somewhat of a new buying task	a fairly new buying task	a completely new buying task

B.2.9 Purchase Importance, PI

The four measures of purchase importance include: product selling price, typical order size, typical customer time commitment, and effect on profitability of the typical customer. The product selling price was determined during the interview (Item B.3.2), while the last three measures were obtained using the mailed questionnaire:

The average order size of a typical purchase of this product will likely be $ _____

If he buys our product, the typical customer will then be committed to using our product for a period of approximately _____ months or _____ years.

For potential customers the purchase of this product will likely have	no effect on their profitability	a pretty low effect on their profitability	a moderate effect on their profitability	a great effect on their profitability	a very great effect on their profitability

The two continuous measures were coded according to the following scheme:

Category	Order Size	Time Commitment (years)
1	< $1000	< 1
2	$1001-5000	1.1-2
3	$5001-10,000	2.1-5
4	$10,001-100,000	5.1-10
5	> $100,000	10

B.2.10 Number of Market Segments, MS

The potential customers for this product will be	all in a single industry	mostly in a single industry	in a few different industries	in several different industries	in many different industries

B.2.11 Customer Accessibility, CA*

Customer accessibility was measured in two ways:

As sources of information about customer needs and competitive products, the potential customers for our product will be	very willing to cooperate	fairly willing to cooperate	somewhat willing to cooperate	not very willing to cooperate	not at all willing to cooperate
For purposes of gathering market information, the potential customers for this product will be geographically	very accessible	fairly accessible	somewhat accessible	fairly inaccessible	very inaccessible

B.3 MEASURES OBTAINED DURING THE SECOND INTERVIEW

B.3.1 Anticipated Payoffs

Three measures of the anticipated payoffs of the project were proposed and include: average annual sales, average annual profits, and discounted profits. The following question secured the needed data to calculate payoffs:

> At the very beginning of the new products' development, the products' future prospects had probably been assessed at least in some general terms, even if there were few clear indications of the future. We would like to know what management's beliefs were at that time about a number of factors:

First Estimates or Impressions of:

Year	(a) Dollar Sales Volume	(b) Selling Price
1	$_____	$_____
2	_____	_____
3	_____	_____
4	_____	_____
5	_____	_____

(c)	Direct Manufacturing Cost	$_____
(d)	Direct Selling Expenses	$_____
(e)	Total Development Cost	$_____
(f)	Total Capital Investment	$_____
(g)	Number of Years Product would be sold	_____ years

Average annual sales (S) was the average of the expected sales for the first five years or for the product's life, whichever is shortest (item a). Average annual profits (PR) equalled the average annual sales multiplied by the profit margin, where profit margin is:

$$\% \text{ PM} = \frac{\text{Selling Price - Mfg. Cost - Selling Expense}}{\text{Selling Price}} \text{ X } 100\%$$

Discounted profits were calculated by determining the present value of expected sales at each of four discount rates (15%, 25%, 40% and 50%) for the life of the product, and multiplying by the profit margin. Where the expected life of the project exceeded five years, the fifth year sales estimates were used for future years. The discounted profits at 15%, 25%, 40% and 50% are designated DPR-1, DPR-2, DPR-3 and DPR-4 respectively.

B.3.2 Purchase Importance (Selling Price), PI

The fourth measure of purchase importance is the expected selling price, obtained from item (3.1.b) above. Selling price was coded as follows:

Category	Selling Price
1	< $1.00
2	$1.01 to $100
3	$101 to $1000
4	$1001 to $10,000
5	> $10,000

B.3.3 Payback Period, PP

The payback period was calculated from estimates from item (3.1) above.

$$PP = \frac{\text{development costs + investment}}{\text{sales X profit margin}} = \text{years}$$

B.3.4 Time Urgency of Development, TU

At the beginning of the first stage of development, how quickly did it seem that the project should proceed? That is, how urgent was it that there be fast action on development. You can answer using the following card

					Code:
very little if any urgency	some degree of urgency	moder-ately urgent	quite urgent	very urgent	1 to 5 left to right

B.3.5 Managerial Success Rating of the New Product Program

How would you rate the success of your firm's new product development program over the past five years? You can answer using the following card:

					Code:
not successful	a minor success	moder-ately good success	very successful	extremely successful	1 to 5 left to right

TABLE B.1

DESCRIPTION OF FIRMS STUDIED BY INDUSTRY AND ANNUAL SALES

Industry	Number of Firms						
		Annual Sales ($ Millions)					
	No Resp.	2 or Less	> 2 to 10	> 10 to 40	> 40 to 100	> 100	Totals
Electrical Equipment, (small and large) Electrical Products; Scientific Instrumentation; Process Instrumentation	2	14	11	2	1	3	33
Chemicals, heavy; Specialty; Pharmaceutical; Protective and Coatings	1	3	8	4	1	6	23
Equipment, light industrial, Components; Machine Tools and Supplies; Material Handling, Vehicles and Equipment; Airconditioning and other Building Equipment	0	7	12	8	3	1	31
Vehicles, components, fabricated metal parts Aircraft, Automotive, Agricultural	1	2	3	7	3	2	18
Miscellaneous, including Industrial Textiles; Plastic and Rubber Fabricated Parts, Construction Materials, Packaging Materials, Other Raw Materials	2	1	2	4	3	1	13
Totals	6	27	36	25	11	13	118

APPENDIX C

SUPPLEMENTARY TABLES OF EMPIRICAL FINDINGS

TABLE C.1

FREQUENCY DISTRIBUTIONS OF VARIABLES MEASURED (118 CASES)

VARIABLE	CATAGORIES* AND PERCENTAGES OF CASES**					TOTAL
Amount of Market Assessment (Manhours)	(0-25) 14%	(25-50) 14%	(50-100) 8%	(100-150) 3%	(150-200) 10%	100%
	(200-250) 11%	(250-500) 8%	(500-1000) 12%	(1000-2500) 11%	(> 2500) 8%	
Possible Cost of Failure ($000)	(0-5) 9%	(5-15) 12%	(15-25) 8%	(25-50) 14%	(50-100) 11%	100%
	(100-200) 9%	(200-300) 6%	(300-500) 10%	(500-1000) 10%	(>1000) 10%	
Anticipated Annual Sales ($000)	(0-50) 11%	(50-100) 14%	(100-150) 5%	(150-250) 11%	(250-350) 9%	100%
	(350-600) 9%	(600-1000) 8%	(1000-1500) 11%	(1500-4000) 12%	(>4000) 9%	
Anticipated Annual Profits ($000)	(0-10) 9%	(10-30) 11%	(30-50) 12%	(50-100) 13%	(100-150) 9%	100%
	(150-200) 6%	(200-300) 11%	(300-500) 9%	(500-1000) 8%	(>1000) 11%	

*Catagories are indicated in parenthesis: for example (10-15) means greater than 10 and up to 15.

**Percentage of cases are shown in large type. Percentages may not add exactly to 100% due to rounding.

TABLE C.1 Continued

FREQUENCY DISTRIBUTIONS OF VARIABLES

Variable Name	Item Number in Appendix B	Frequency Distribution: Percentage of Cases in Each Catagory* Catagories (See Appendix B for catagory definitions) 1	2	3	4	5	Totals
Relative Cost of Failure	2.1	23%	3%	39%	8%	28%	100%
Market Newness to Company	2.2	5%	36%	28%	24%	8%	100%
Market Stability	2.3	0%	9%	38%	43%	9%	100%
Product Newness to Market	2.4	8%	27%	31%	14%	19%	100%
Degree of Competition	2.5	5%	6%	45%	36%	8%	100%
Technical Newness to Company	2.6	5%	18%	29%	21%	27%	100%
Product Complexity	2.7	3%	31%	49%	14%	3%	100%
Purchase Task Newness	2.8	33%	39%	13%	13%	3%	100%
Purchase Importance - Selling Price	3.2	16%	27%	22%	14%	20%	100%
Purchase Importance - Order Size	2.9	19%	22%	10%	34%	15%	100%
Purchase Importance - Time Effect	2.9	33%	9%	23%	21%	14%	100%
Purchase Importance - Profit Effect	2.9	14%	23%	43%	14%	5%	100%
Payback Period	3.3	19%	21%	24%	23%	14%	100%
Number of Potential Customers	1.3	4%	27%	21%	28%	19%	100%
Number of Market Segments	2.10	30%	34%	16%	11%	9%	100%
Customer Accessibility - Willingness	2.11	0%	3%	18%	38%	42%	100%
Customer Accessibility - Geographic	2.11	2%	11%	9%	53%	28%	100%
Time Urgency Development	3.4	10%	21%	18%	34%	17%	100%

*Percentages may not add exactly to 100% due to rounding.

TABLE C.2

RESULTS OF FACTOR ANALYSIS AND REGRESSION ON PRINCIPLE COMPONENTS[1]

Variable Name	VARIMAX ROTATED FACTOR MATRIX[2] FACTORS[3]								Communalities[4]
	1	2	3	4	5	6	7	8	
Cost of Failure	.840[5]	.182						.247	.844
Annual Sales	.626		.298	.226		.255			.608
Relative Failure Cost			.245					.393	.244
Market Newness			.410						.202
Market Stability			-.239	-.378			-.200		.274
Product Newness		.407	.304	.312	.441		.259		.640
Degree of Competition	.204	-.211	-.152		-.389	.519	.261	.230	.658
Technical Newness			.420		.233				.295
Product Complexity		.209		.517	-.234	.177	.200	.338	.554
Purchase Task Newness		.156	.510	.426					.492
Purch. Import. - Price		.629							.429
Purch. Import. - Order Size	.352	.377		.408		.155	-.200		.531
Purch. Import. - Time		.730	-.166				.176		.623
Purch. Import. - Profit				.720	.219				.620
Payback Period	.197				.183			.546	.406
Number of Customers							.640		.455
Number of Segments			.462						.269
Cust. Access. - Willingness					.636				.416
Cust. Access. - Geog.		-.476	-.283			.287			.417
Time Urgency of Development						.528	-.156		.325
Factor, Eigenvalves	3.053	1.431	1.203	1.071	0.819	0.693	0.552	0.483	
% Common Variance Explained by Each Factor	32.8	15.4	12.9	11.5	8.8	7.4	5.9	5.2	
Regression Beta Coefficient[6]	.518*	.044	-.053	.083	-.032	.131*	.042	.083	

NOTES:

1. All variable values were in logarithmic form.
2. The values of the rotated factor matrix indicate the loadings of each variable (in standard form) on each of the eight generated factors. For example, reading across the first row: Cost of Failure = $.840F_1 + .182F_2 + .247 F_8$.
3. Eight factors were generated; these are denoted "1" through "8".
4. Communalities indicate the percent variance of each variable explained by the eight factors. For example, the eight factors explain 84.4% of variations in the Cost of Failure, but only 20.2% of variations in Market Newness.
5. Only factor loadings of 0.15 or greater are shown. A factor loading of 0.15 is evidence that the loading is statistically significant ($\alpha <$ .10, two tail t-test).
6. The amount of assessment was regressed against the factor values for each of the 118 new product cases, to yield the Beta Coefficients shown. Only two factors, denoted by an asterisk, were statistically significant ($\alpha <$ .10, two tail t-test). Multiple $R^2 = .334$.

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