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I am submitting herewith a dissertation written by Terry Lynn Payne entitled "The Strategic Importance and Effectiveness of Key Decision Criteria in the Selection of Research Areas." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in business administration.

Dr. Michael J. Stahl, Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor
and Dean of the Graduate School

THE STRATEGIC IMPORTANCE AND EFFECTIVENESS OF KEY DECISION CRITERIA IN THE SELECTION OF RESEARCH AREAS

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Terry Lynn Payne

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DEDICATION

This dissertation is dedicated to

my wife, Lee Ann Parrott Payne

my son, David Thomas Payne,

my mother, Margie Jean Payne,

and

the memory of my father, Gene Payne,

all of whom have provided me with endless love,

encouragement, understanding, and inspiration throughout my doctoral studies.

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ABSTRACT

To maximize the benefit of research investments to the business firm, research and development (R&D) related decisions (e.g., selection of research areas) should complement the firm's chosen basis for competing in the market. This has been stated by numerous authors, including Ansoff (1984), who recognizes that the technology and competitive strategies of a firm should be compatible.

Maidique and Patch (1988) identify six R&D-related decisions made by firms. These decisions form a technology policy that should round out the firm's competitive strategy. One of the most important aspects of technology policy is the selection of research areas in which to invest. This dissertation focuses on this selection and examines the correlation between economic performance and the amount of emphasis placed upon the two selection criteria identified by Maidique and Patch (i.e., relatedness and opportunity).

To accomplish this task, (1) a decision-making exercise was given to individuals (Chief Executive Officers and Vice Presidents of R&D) involved in the process of selecting research areas for firms in the pharmaceutical preparation industry (SIC 2738), and (2) the decisions of those managers were modelled. Based upon 53 responses received, this dissertation documents the correlation between Maidique and Patch's stated criteria for selecting research areas, namely opportunity and relatedness, and three measures of business economic performance, namely, return on investment, sales growth, and net income growth. The results revealed only a small correlation ranging from 0.01 to 0.12. When multiple factors (i.e., degree of relatedness of a research area, degree of opportunity of a research area, whether or not the decision maker possesses a Ph.D. degree, and the primary competitive basis utilized by the firm) were regressed against the business economic performance indicators and contrary to Maidique and Patch's theory, the largest parameter estimate was associated with

whether or not the person selecting the research areas for investment possessed a Ph.D. degree. The second largest parameter estimate was associated with the primary basis for competing utilized by the firm (i.e., low price or product differentiation).

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CHAPTER I. INTRODUCTION AND PURPOSE

This dissertation has resulted from the following two general assessments.

1. Technology and business performance are poorly linked by existing strategy literature and paradigms.
2. Technology can be a valuable competitive weapon if it complements the firm's competitive strategy.

Thus, this dissertation examines a topic that is of interest both to the practitioner and the academician. The practitioner may obtain some insight into the pattern by which decisions are being made, while the academician will be provided with an expansion of the existing knowledge concerning the relationship between technology and competitive strategy, an expansion that leads to many additional research questions.

This introductory chapter is intended to provide a brief understanding of key concepts, a summary of the motivation for the study (i.e., applicability), and a general purpose. To achieve this, the introductory section is arranged into four distinct subheadings: "Strategic Management Models and Technology," "Three Elements of Technology," "Technology and Increasing Competition," and "Purpose." The following chapters comprise a more detailed literature review (Chapter II), a discussion of the theoretical model (Chapter III), a discussion of data sources and methodology (Chapter IV), the results of data analysis (Chapter V), conclusions (Chapter VI) and implications for future research (Chapter VII).

Strategic Management Models and Technology

Schendel and Hofer's (1979) strategic management process model is typical of strategic management models in that it does not explicitly identify the points in the strategic management process at which one should consider technology. Rather, their model implies that either technology should be considered in the environmental analysis (and, thus, impact strategy formulation, evaluation, and implementation, but not goal formulation nor strategic control) or technology should be considered as a static variable and not considered at all in the strategic management process. Both approaches result in suboptimization and increased risk due to utilization of incomplete data.

Like Schendel and Hofer's model, Pearce and Robinson's (1988) strategic management model does not explicitly consider technology. Again, because technology is not explicit in Pearce and Robinson's model, any consideration of technology must be accomplished as part of the environmental analysis. Viewing technology as depicted in the Pearce and Robinson model, implies that technology should be considered when determining the company profile (i.e., determining possible goals and objectives with respect to strategy formulation), analyzing alternative strategies, and selecting the strategy to be implemented, but not in the actual implementation nor the day-to-day control of the strategy.

Thus, these two strategic management process models reduce the role of technology to that of a static parameter which impacts only some of the points in the strategic management process. The lack of adequate consideration of technology by these models incorrectly implies that technology is of minimal importance to the strategic management process.

Some strategic management theorists have recognized the importance of technology. For example, Andrews (1980) argues that technology-related decisions are of singular importance and must be carefully evaluated. However, that model of strategic management does not provide assistance in identifying, assessing the impact of, or making the important technology-related decisions.

Other strategic management theorists who recognize the importance of technology include Maidique and Patch (1988), Porter (1985), and Ansoff (1984), all of whom recognize the critical relationship between a firm's technology policy and the chosen competitive basis selected by the firm. Specifically, Maidique and Patch assert that a firm's technology policy should be merged with its competitive strategy. They maintain that the firm's technology policy is formed when decisions are made concerning the following:

- selection of technology areas in which to invest,
- level of competence desired and attainable,
- preferred sources of technology information,
- R&D investment level,
- competitive timing, and
- R&D organization and policy.

Maidique and Patch (1988) identify two key decision criteria to consider when selecting technology areas for investment. The first criterion, internal technological fit, can be assessed based upon the response to the following question: What technologies are promising from the perspective of existing or anticipated products? Thus, internal technological fit is an assessment of how relevant the technology area is to the organization's products. The second criterion, external market opportunity, can be assessed based upon the response to the following question: What technologies have potential for improving product performance or lowering product costs? Thus, external market opportunity is an assessment of the potential of a technology area to improve the competitiveness of the organization's product(s).

Three Elements of Technology

Burgelman, Kosnik, and van den Poel state that technology "refers to the practical knowledge, know-how, skills and artifacts that can be used to develop a new product/service and/or new production/delivery system" (1988: p. 32). Thus, as stated in *Industrial Engineering* (1990), a macroscopic view of technology reveals three distinct but interrelated elements: acquiring the knowledge (research), searching for generic uses of the knowledge (development), and applying the knowledge to the specific requirements of a business (engineering).

Note that the National Science Foundation (NSF) definitions associated with research and development are slightly different. The NSF definition of basic research (i.e., original investigations for the advancement of scientific knowledge not having specific commercial objectives) is approximately equivalent to the previously stated definition of research. If the NSF definitions of applied research (i.e., investigations directed to the discovery of new scientific knowledge having specific commercial objectives with respect to products or processes) and development (i.e., technical activities of a nonroutine nature concerned with translating research findings or other scientific knowledge into products or processes) are combined, the result is approximately equivalent to the previously stated definition of development. For simplicity, this research will use the names and definitions of the technology elements as defined in *Industrial Engineering*, namely, research, development, and engineering. Each of the next three paragraphs focuses on one of these elements and expands upon the preceding definitions.

Research is the search for new scientific facts and is often the source of the knowledge that predicates activities in the other elements of technology (i.e., development and engineering). The new knowledge may be applicable to any of the areas of physical, biological, or social nature. Furthermore, research is the element of technology that involves the largest degree of uncertainty because the end result (what is being sought) is least defined. Thus, research is the technology element with the largest degree of investment risk. In concluding our general discussion of research, Bylinski's (1990) assessment should be restated, namely, that research, although risky, often pays spectacular dividends.

Development uses knowledge of science for the primary purpose of solving generic problems. In this process, development itself sometimes results in the discovery of new knowledge, as would be expected of research. As an example of the difference between research and development, the discovery of the electron may have resulted from "research," but the field of electronics was "developed" based upon application of the scientific properties of electrons.

Engineering refers to the efforts associated with applying the solution derived in the development process to the specific inputs and requirements of the business. Thus, engineering is the application of knowledge to a specific business purpose in support of a particular firm's competitive strategy. Stated another way, engineering utilizes scientific knowledge to translate knowledge into useful products and processes.

As stated previously, each element of technology has different purposes and objectives. Horwitch and Sakakibara (1981) contrast the technology elements of research, development, and engineering with respect to general objectives, desired organization formality, and degree of risk. In conclusion, Table 1 summarizes their study on the elements of technology.

Technology and Increasing Competition

A current trend that amplifies the importance of technology and the efficient use of resources is the increase in the number of competitors in most markets. Global competition

Table 1. Key Differences in Technology Elements*

Technology Element			
General objective	*Example*	*Desired organization formality*	*Level of uncertainty/ risk*
Research			
Discovery of new scientific knowledge	Identify and correlate important properties of heat transfer process that can be used to optimize heat sink capabilities of evaporating thin films	Low	High
Development			
Focus scientific knowledge to new methods of strategy support	Apply properties of the heat transfer process to optimize aircraft wing durability	Moderate	Moderate
Engineering			
Directly support a firm's selected competitive strategy via the application of scientific knowledge	Design wing and wing production facility for aircraft with increased wing durability	High	Low

*Adapted from Horwitch and Sakakibara (1981).

is one factor resulting in an increase in the number of competitors, an increase that has many strategic impacts upon a firm.

Corresponding with the increase in the number of competitors is a reduction in resources to support research. Increased competition results in a decline in the availability of discretionary funds via a reduction of profit margins; therefore, because research is an uncertain and risky element of technology, discretionary technology funds are more likely to be diverted to the less risky elements of development and engineering in an attempt to avoid the large investment required by research endeavors. This avoidance of research results in suboptimization as the firm forgoes risks associated with a potentially larger, long-term advantage for the smaller, more certain, short-term benefits. It is transparent that a declining investment in research increases the importance of focusing the reduced research resources on technology areas that will positively impact performance in the market.

Purpose

The formal purpose of this research was to determine the effectiveness of the two decision criteria proposed by Maidique and Patch (1988), namely internal technological fit and external market opportunity, to be used in a firm's selection of research areas. For the strategic decision of selecting research areas, effectiveness was evaluated on the basis of three business economic performance measures (i.e., sales growth, net income growth and return on investment). Data for analysis were obtained from the pharmaceutical preparation industry and, specifically, from the responses to a questionnaire provided by decision makers involved in the research area selection process.

Multiple benefits resulted from this research as a result of an increased understanding of the important variables to consider when firms select research areas in which to expend their resources. For academicians, this research has led to many potential research areas involving the relationship between technology, strategy and economic performance (see Chapter VII). In addition, this research, while not attempting to show causality, has provided practitioners with a view of the correlation between the research area selection practices of the pharmaceutical preparation industry and three key economic performance measures.

CHAPTER II. LITERATURE REVIEW

Many have recognized potential impacts of technology upon strategic management. Theorists such as Drucker (1980), Porter (1985), and O'Connell and Zimmerman (1979) discuss some of the specific interrelationships between strategy and technology. However, most strategic management research on the impacts of technology is less than comprehensive due to limiting assumptions or scopes. Some examples of the limitations placed on the scope of strategic management research on technology (and some of the authors performing this type of research) follow:

- technology's role in inducing innovation (e.g., Kanter, 1983);
- manufacturing technology and the strategy formulation process (e.g., Hayes and Wheelwright, 1984; Wheelwright, 1985);
- technology's impact on the degree of vertical integration (Balakrishnan and Wernerfelt, 1986); and
- technology's impact on existing managerial practices (Jelinek and Goldhar, 1983).

Instead of addressing technology in a macroscopic manner, all of these studies attempt to look at the impact of technology on a specific aspect of strategy. Thus, any possible interactions between technology and other areas of strategic importance are ignored. Because technology is a multidimensional concept that varies with respect to the technology area, a macroscopic perspective is necessary to determine its effects upon business performance.

While expounding upon his statement that "a critical link between strategy and technology exists," Kantrow (1983) suggests that technology should not replace any existing tool but that an attempt should be made to view technology in strategic terms. This is perceived as the necessary first step in developing an eclectic view of the relationship between strategy and technology. As alluded to earlier, no single literature topic exists that provides the necessary macroscopic view of the interactions between technology and strategic management. Therefore, this research will view technology in strategic terms by reviewing some of the germane literature. To accomplish this task, the literature reviewed is applicable to the following general categories:

- technology,
- technology and strategy,
- technology policy,
- strategic decision making,
- key perceptions of the decision maker,
- assessing the effectiveness of technology, and
- organization culture and research.

While some specific literature may arguably be applicable to more than one of the above subheadings, an attempt was made to place the literature in the most appropriate section.

Technology

Technology is often incorrectly thought of in such limiting terms as "anything mechanical" or "something new." Burgelman, Kosnik, and van den Poel state that technology "refers to the practical knowledge, know-how, skills and artifacts that can be used to develop a new product/service and/or new production/delivery system" (1988: p. 32). After accepting this simple definition, technology can be segmented into its three elements: research, development, and engineering. It can be inferred from the prior definition that technology depends on knowledge. Thus, we can define "research" as searching for new scientific knowledge. The word "practical" in the preceding definition also implies that technology involves the application of knowledge to a purpose. Thus, "development" is the utilization of knowledge of science for a generic application. Lastly, the fact that the preceding definition mentions "new product/service and/or new production/delivery system" implies that technology can be used to serve a specific purpose. Thus, we can define "engineering" as the implementation of technology into a specific business with a defined set of inputs and requirements.

As stated, technology is multidimensional. Thus, technology can not only be viewed in terms of its three components; it can also be assessed with respect to other factors of strategic importance, such as turbulence and intensity. Ansoff defines technological turbulence as "change-ability in an environment characterized by the degree of novelty of challenges and the speed with which they develop" (1984: p. 486). Ansoff also states that technological intensity is reflected in six areas: relative investment in R&D, competitive positioning, product dynamics, technology dynamics, competitive dynamics, and overall evaluation (1984: p. 110-111).

The turbulence and intensity of the key technology of an industry have many strategic implications. Porter (1985) is clear in his assertion that a nonturbulent (i.e., stable) environment favors first movers, because technological turbulence might provide followers with a competitive weapon necessary to overcome the first-to-market advantage. Lieberman and Montgomery (1988) identify the three primary advantages to being first mover as (1) rapidly proceeding down the learning curve, (2) an ability to preempt rivals in the acquisition of scarce resources, and (3) eliminating costs associated with switching products. All three are impacted by the turbulence and intensity of the industry's key technology. Lieberman and Montgomery also identify the advantages of being a follower or late entrant as the ability to "free-ride" on first mover investments, resolution of technological and market uncertainty, technological discontinuities that may provide new paths for entry, and avoiding certain types of inertia that make it difficult for the incumbent to adapt to environmental change.

Based upon the works of Porter, sustainability is identified as a third dimension of technology. Porter defines sustainability as the ability to maintain a technological advantage because competitors cannot duplicate the technology and/or the firm develops as fast or faster than competitors can catch up (1985: pp. 182-183). Thus, a firm should consider turbulence, intensity, and sustainability when evaluating the potential impact technology may have upon its competitive situation and when evaluating the relative emphasis to place upon research, development, and engineering.

As stated in Chapter I, research involves more financial risk than development and engineering. Therefore, when a firm is considering the level of investment to make in research activities, typical considerations are

- whether the technology is turbulent,
- whether the market is technologically intense,
- whether the technology is appropriable, and
- the strategic importance of being first-to-market in the particular industry of interest.

Technology and Strategy

Fusfeld and Langlois (1982) state that almost every executive knows of business successes in which technology has played a dominant role. Intel Corporation, Minnesota Mining and Manufacturing (3M), Polaroid, and Hewlett-Packard are real-life successes at turning profits from dreams of technology. However, despite the obvious role of technology in superlatively successful enterprises, rarely are technology issues included in business strategy reviews.

In discussing generic technological strategies, Porter (1985) concludes that a clear linkage between technological strategy and an overall view of industry competition is lacking. Technology is an important strategic consideration for many reasons, most of which can be associated with competition in the market. Therefore, the purpose of this section of the literature review (to show a link between technology and competition in the marketplace) will be accomplished by discussing some of the critical technology-strategy links. Specifically, only the following major links between technology and strategy will be discussed in detail:

- technology can alter the structure of an industry (Willard and Cooper, 1985);
- technology impacts competitive advantage (Porter, 1985); and
- technology can represent either an external market opportunity or a threat (O'Connell and Zimmerman, 1979).

Willard and Cooper (1985) assert that the power of an individual technology as a competitive variable lies in its ability to alter the industry structure, not on the technology's specific scientific merit or its ability to serve market needs per se. If the industry structure is alterable, then a firm's assumptions during the strategy formulation process should anticipate potential changes, especially any changes that could significantly impact the firm. Thus, because technology can impact the industry structure, an assessment of the key technology characteristics should be considered in the strategy formulation process.

While the relative importance of technology as a competitive strategy support tool varies from industry to industry and potentially from firm to firm, technology provides nearly all firms with opportunities for improvements in their relative competitive positions. Porter (1980) concludes that this is possible by the ability of technology to alter the industry structure. Specifically, Porter concludes that technology can be used by any organization to alter the relative strengths of the five market forces (competitors, threat of new entrants, suppliers, customers, and substitute products) to match its internal strengths and to minimize the vulnerability associated with its weaknesses. An example of a way the strength of each of the five competitive forces can be altered by technology is shown in Table 2.

Porter (1985) further acknowledges that technological change ranks as one of the principal drivers of competition in an industry and proposes that technology advancements could alter the balance among the industry structure. He purports industry structure to be defined by the relative strengths of the five competitive forces. Porter posits that each of the forces possesses some relative strength within each industry. The term "relative strength" was used to imply the degree of control each force has upon the industry competition. Thus, at any given time the buyers, sellers, competitors, threat of new products, and threat of new entrants have a certain relative amount of influence over the competition and, thus, on the success of the strategies of all firms competing within that industry.

O'Connell and Zimmerman (1978) report that technology can represent either a market opportunity or a market threat. They recognize that technology makes a significant difference in market-place competition. For example, technology may provide an entrance to a heretofore excluded market, or technology may lower the entry barriers to the current industry, thus increasing the threat of new entrants.

Furthermore, although the basis for competing is determined to a large degree by customers and competitors, technology has been stated to be a significant strategic factor regardless of the firm's chosen basis for competing (i.e., price leadership, differentiation, or focus). Ansoff (1984) also asserts the importance of technology by recognizing the necessity of developing and integrating a technology strategy with the business and competitive

Table 2. Examples of Technology Altering Industry Structure *

Market force	*Way in which technology can alter relative strength*
Buyers	Technology can be used to alter buyer power by varying the degree of product differentiation.
Competitors	Technology can be used to provide a competitive advantage via a unique capability.
Suppliers	Technology can be used to increase (or decrease) a firm's dependence upon its suppliers by identifying alternative raw materials to use.
Substitutes	Technology may result in a totally new product that fulfills the function of an existing product.
New entrants	Technology can be a source of raising (or lowering) industry entry barriers by increasing the fixed costs of competing in an industry (e.g., increasing manufacturing equipment costs).

* Adapted from Porter (1985: pp. 173-175)

strategies of all firms. Thus, the importance of technology to competitive strategy is well documented and is founded in the facts that it

- can alter the industry structure of any competitive environment,
- can impact any firm in a competitive environment,
- can impact any competitive strategy, and
- is a competitive weapon that a business either chooses to use or is vulnerable to have used against it (Porter, 1980).

Technology Policy

Maidique and Patch state that "technology is a vital force in the competitive environment of the modern firm. This is especially so in technology-intensive industries such as aerospace, computer, chemical, and drug industries" (1988: p. 236). Because technology is a vital force in the industry structure, the match between technology policy and competitive strategy is crucial.

Maidique and Patch also state that a business defines its technology policy when it makes choices between alternative new technologies, the criteria by which new technologies are embodied into new products and processes, and the deployment of resources that will allow successful implementation of the technologies. Specifically, Maidique and Patch (1988) theorize that the first area a firm must address in forming its technology policy is the selection of technology areas in which to invest (i.e., in which technologies should we invest?).

In an effort to make their work applicable to all components of technology, Maidique and Patch list the following two key questions to be asked in the selection of research areas:

1. What technologies are promising from the perspective of the existing or anticipated products?

2. What technologies provide potential for improved product performance o product cost?

Maidique and Patch refer to the answer to the first question as the decision-maker's assessment of the "relatedness", or internal technological fit, associated with a research area. Likewise, the answer to the second question is referred to as the "opportunity", or external market opportunity, of the research area.

These are consistent with other studies. For example, two of Pake's (1981) criteria for research investment are the estimated relevance to a firm's projected areas of business interest and the expected results for dollars invested, which Pake refers to as "ripeness" of the technology area. Note that the first of Pake's factors could be deemed equivalent to the Maidique and Patch research area selection criterion termed internal technological fit, while the second could be associated with the Maidique and Patch selection criterion termed external market opportunity.

Strategic Decision Making

Schilit and Paine (1988) utilize the concept of strategic decision making as the process by which decisions are made that impact the performance of the firm and its ability to achieve goals and objectives. Strategic decision making may occur at any level of the organization, although the significant premeditated choices are typically made by executives. Decision criteria are the factors that influence the decision-making process.

While many variations may exist, the strategic decision-making process can be viewed as involving three steps. The first step is identifying the question to be answered, or problem formulation. The second step is to identify alternative solutions to the problem given resource constraints. Finally, the third step is to actually make a selection among the alternatives.

In addition to viewing strategic decision making as a three step process, many other significant observations of strategic decision making have been made. For example, strategic decisions are those important decisions that match the organization's capabilities against threats and opportunities in order to enhance long-term success (Schilit and Paine, 1988). Also, strategic decisions have a long time frame and an impact on organizational rather than individual outcomes. Additionally, strategic investment decisions are investment decisions with major long-term implications for the firm (Barwise, Marsh, Thomas, and Wensley, 1987). All of these are germane to the selection of research areas for investment.

Frederickson and Mitchell (1984) describe the strategic decision-making process as either

- a highly rational and proactive synoptic model involving activities such as establishing goals, monitoring the environment, assessing internal capabilities, searching for and evaluating alternative actions, and developing an integrated plan to achieve the goals or
- an incremental model that includes a group of incremental processes often offered as alternatives or, more simply, as a more accurate characterization of how organizations actually make strategic decisions.

However, Stahl (1989) considers strategic decision making as a synoptic model. Consistent with Stahl's work, it is important in this dissertation to distinguish between the subjective weights of decision criteria and the relative weights of decision criteria. The subjective weight is the decision maker's a priori stated importance of a decision criterion.

The relative weight is the actual weight placed upon each criterion and is determined via modelling of the decision-makers' responses to a decision-making exercise.

While Stahl's approach is based upon the assumption of rational choices, it is recognized that many authors such as Bower (1970), Allison (1971), Pettigrew (1973), Mumford and Pettigrew (1975), March and Olsen (1976), and Quinn (1980) have started to redirect research on decision making and change from its prevailing concern with rational analytical schemes of intentional process and outcome to a variety of process modes. These process theories are commonly expressed in the language of bounded rationality, "incrementalism," politics and power, and March and Olsen's (1976) garbage can frame of reference for considering problem solving.

Specifically, Bower (1970) develops the perspective of strategy evolving through the various levels of the organization through processes characterized as chains of commitment leading to eventual confirmation. Phase metaphors describing the life history of investment proposals from definition to impetus are described in political terms. Top managers are seen to determine the structural context through which capital proposals will pass and be filtered. Dutton and Duncan (1987) state that strategic decisions flow out of activities taking place at multiple levels of the organization. Mintzberg (1978) conceives of strategy as consistency over time in a pattern of decisions. This approach allows him to distinguish between intended and emergent strategy and to pinpoint strategies contributed after the fact or, as he puts it, realized despite intentions.

Empirical process research has made a number of descriptive contributions to the understanding of strategic decision making and change. Strategic processes are now accepted as multilevel activities and not just the province of a few, or even a single, key manager. Hardy and Pettigrew (1985) conclude that outcomes of decisions are not just a product of rational or even bounded rational debates but are also shaped in the political interests and commitments of individuals and groups, the forces of bureaucratic momentum, gross changes in the environment, and the manipulation of structural context around decisions.

Because resources are limited, every manager faces the dilemma of allocating research dollars to the area most advantageous to the firm (Link and Tassey, 1987). Link and Tassey further purport that while selection of research areas is of strategic importance, it generally defiled any precise prescriptions. In other words, a simple, formulaic approach to decision making is rarely, if ever, applicable.

Many synoptic management science models for selecting R&D projects have been proposed (Cetron, Martino, and Roepcke, 1967; Souder, 1972; Baker, 1974; Souder, 1978). These normative models for R&D project selection utilize approaches that are systematic in nature. However, each of these synoptic models fails to consider the many important qualitative factors. Rather, these models are poor adaptations of project selection models to a more complex concept that relies less on objective data and more on perceptual data.

Many of the ideas and methods of the synoptic (i.e., management science) models are appropriate when selecting research areas. However, these models apparently do not reflect the decision-making process being used by managers (Cetron, Martino, and Roepcke, 1967; Souder, 1972; Baker, 1974; Souder, 1978). Also, this dissertation topic differs from any of the aforementioned models in that of primary importance is the selection of research areas, not an individual project.

Decision making in today's larger corporations is characterized by the fact that the strategy rarely emerges as a single comprehensive decision made by the managing director or even one department. Instead, the firm's strategy is based upon a number of strategic decisions, each of which has been made by several managers within their areas of responsibility (Hegarty and Hoffman, 1987). Thus, if research within an organization is centralized, the selection of research areas may be largely influenced by, if not totally determined by, one individual.

It has been recognized that some technology-related decisions are strategic decisions. Miles and Snow (1978) identify three general types of strategic decisions that must be made for a firm to adapt to its environment: (1) choices of products and markets; (2) selection of technologies for supplying, producing, and distributing goods/services; and (3) administrative choices of structure and management systems.

Strategic decisions have a long time frame and an impact on organizational performance, rather than merely individual outcomes. Thus, selections of strategic technology areas are strategic decisions in that R&D requires a great deal of time and expertise in certain technology areas. Furthermore, selection of strategic technology areas has been shown to be correlated strongly with economic performance (Schilit and Paine, 1988).

In an attempt to understand strategy formulation, Shrivastava (1987) states that strategic decision making refers to the set of activities performed by organization members and their associates, from the time they identify and formulate strategic threats or opportunities until the time they make a formal commitment of organizational resources for dealing with opportunities or threats.

Thus, selection of research areas is a strategic decision because

- research requires an uncertain amount of time,
- research consumes organizational resources,
- expertise in certain technology areas is correlated strongly with economic performance (Schilit and Paine, 1988), and
- industry structure is influenced by technology.

Hence, an example of a strategic decision in an organization is the decision of where to apply resources to ensure competence in technology areas.

Key Perceptions of the Decision Maker

Of course, strategic decisions are made by humans. Thus, the knowledge level and perspective of the decision maker strongly influence the selection of research areas. Because the degree of Doctor of Philosophy (Ph.D.) is generally associated with training in the art of performing research, this section discusses some of the literature on the perspectives of persons possessing the Ph.D. degree that might impact their selection of research areas in a way not expected of persons not possessing the Ph.D. degree.

Eiduson (1962), in her study of research scientists, finds that researchers have developed certain ways of thinking and perceiving that tend to be the principles they use when confronted with unfamiliar and unstructured data. While the researchers typically did not work in scientific situations or on scientific problems in the same nonstructured way, it seems that the cognitive intuition researchers display in response to an ambiguous test is also applied when looking at scientific problems. Further, the researchers are found to respond to abstract data in a fairly consistent manner. Thus, the way a decision maker perceives external market opportunity and internal technological fit of research areas is impacted by whether the decision maker understands the basics of research.

Maslow (1966) establishes some early tenets on the motivations and personalities of scientists performing research. Maslow states that researchers are interested in the search for truth and that they deliberately, willingly, and consciously proceed in a systematic manner. Maslow further discusses the affinity of researchers for dealing with and searching for abstract knowledge as opposed to persons dealing with and attempting to apply experiential knowledge. Thus, researchers are characterized as desiring to discover the as yet unknown;

therefore, there is a basis for them to perceive risk and external market opportunity of research areas in a consistent manner.

Mendelsohn, Roe, Saunders, Siepert, Kaplan, and Shepard (1963) express specifically the idea that researchers possess the following traits:

- a high degree of autonomy, self-sufficiency, and self-direction;
- a liking for abstract thinking;
- marked independence of judgement; and
- a higher than average willingness to take calculated risks.

These factors are believed to influence the decision-maker's perceptions of the external market opportunity and internal technological fit of research areas. Thus, persons with a comparable understanding of research, such as a group of persons possessing Ph.D. degrees, may view the importance of external market opportunity and internal technological fit in a reasonably consistent manner.

Pelz (1972) recognizes and states that researchers desire to be problem solvers not decision makers. The researchers recognize and understand that much more knowledge is yet to be discovered, and they are motivated by their curiosity and the challenge. Thus, where some decision makers may be wary of certain research areas for fear of the unknowns, a trained researcher should welcome the challenge.

In conclusion, each of the aforementioned studies has found a high degree of consistency among researchers with respect to their approach to decision making when confronted with abstract data, their perceptions, their desire to find the as yet unknown, and their higher than average willingness to take calculated risks.

Assessing the Effectiveness of Technology

Goodman and Penning (1977) point out that certain key questions must be answered before assessing any organization's effectiveness. Specifically, one must answer the following questions.

- What is effectiveness?
- What determines effectiveness?
- What time limits should there be for assessing effectiveness?
- Is organization survival an alternative to effectiveness?

Effectiveness measures are further confounded by the fact that Perrow (1973) defines the existence of three particular types of effectiveness studies. Specifically, Perrow states that effectiveness can be assessed via variable analysis (i.e., changes in variables toward ultimate goal), gross malfunctioning analysis (i.e., assesses poor performers to identify causes of failure), and/or revelatory analysis (i.e., who is getting what). Because this study seeks to relate the degree to which key variables are considered in the selection of research areas to some business economic performance measure, I will use a variable measure of effectiveness.

Effectiveness measures are valid in this study because the goal is to identify organizations on a comparative basis (i.e., one organization is more effective than another, or one organization is more successful at selecting research areas). Perrow (1973) identifies four decisions that must be made associated with the comparative study of organizations:

- the selection of the time period for which effectiveness will be evaluated;
- the arbitrary identification of systems boundaries (difficult for selection of research areas because many benefits may not be directly attributed to the research performed);

- the level of analysis (strategic business unit, corporate, etc.); and
- the identification and moderation of external variables (for this study, industry forces and product development capabilities).

Venkatraman and Grant (1986) identify that a good effectiveness measure has construct validity (measures what it is supposed to) and incorporates both operating and financial performance. Further, Ramanujam and Venkatraman (1987) state that one of the three basic dimensions of organization effectiveness is relative economic performance. Thus, organization effectiveness can be measured by economic performance. Thus, economic performance is a logical measure of research area selection effectiveness.

Venkatraman and Ramanujam (1987) address the measurement of business economic performance from a new perspective when they determine that perceptual data obtained from business managers are strongly correlated with objective economic performance measures. In the study, managers are asked to rank their organization on three business economic performance dimensions (i.e., sales growth, net income growth, and return on investment) with respect to their major competitors. Utilizing confirmatory factor analysis, it is shown that the objective measures of the same business economic performance dimensions and the perceptual measures of the managers are strongly correlated. Thus, the strong degree of convergence among the measurement methods proved that, contrary to previous research conclusions, objective measures are not preferable to perceptual evaluations.

Organization Culture and Research

Deal and Kennedy (1982) treat corporate culture as a cohesion of values, myths, heroes, and symbols that have come to mean a great deal to people who work there. Thus, organization culture and strategic management are intertwined by their multiple impacts upon each other. For example, organization culture impacts power, risk taking propensity, acceptance of change, and organization structures. Each of these impacts acceptance and implementation of technology within the organization. Thus, research in the field of strategic management should not be performed without considering the pertinent organization culture topics.

When selecting research areas, organization culture will impact the decision-maker's propensity to take risks. Thus, it is believed that the organization culture will impact the degree to which a decision maker is willing to pursue a less related research area if the external market opportunity is large. However, while this may be an interesting future research area, the proposed research is attempting to build the foundation upon which research of that type can be based, namely, confirming that selection of research areas is correlated with business economic performance.

One of the lessons learned from past studies linking strategy formulation, strategy selection, and strategy implementation is that this is a political process with its foundation in power (Pfeffer and Salancik, 1974). In other words, selection of a strategy and supporting policies is a political process fostered by the uncertain impact of the strategy alternatives being evaluated. Thus, power of the decision maker may play a role in selection of research areas.

Pfeffer (1981) states that power is the basis upon which organizational choices are made. Pfeffer proposes a model that describes how power is used in decision making and various sources of power, one of which is control of resources. Because the allocation of research resources is a business decision, one source of power in organizations is the ability to control the allocation of resources. Thus, the individual who heavily influences the selection of research areas and, therefore, the allocation of resources is in a position of power. In a related study of power and decision making, Pearce and Robinson (1987) discuss evidence that suggests that Chief Executive Officers (CEOs) provide the primary direction for strategic decision making through the dominance of their firm's social systems.

Pfeffer's (1981) work on power in organizations also discusses assessing personal power in organizations and conditions for the use of power, both relevant to the selection of research areas by a firm. Pfeffer concludes that personal power can be assessed through determinants, consequences, reputations, and representations. In discussing conditions for the use of power, Pfeffer states that a necessary precondition is a conflict. Pfeffer further asserts that power is a function of interdependence, scarcity, and disagreements over actions and consequences. These all are potentially applicable to selecting research areas for investment.

Advancements of technology via research typically necessitate change. Pettigrew (1975, 1980), Quinn (1980, 1982), and Kanter (1983) emphasize the role of power and political processes in managerial strategies for creating change. Kanter describes power skills, team skills, and change architect skills as necessary for holding change ideas together. Power skills are used by leaders to persuade others to invest support and legitimacy in new initiatives. Team skills are necessary to increase the sharing of information, to resolve inevitable differences, and to generate enthusiasm for a particular change alternative. Change architect skills are required to design and construct microchanges that are eventually connected to macrochanges or strategic orientations.

Hence, another aspect of the organization culture that relates to selection of research areas is the degree to which change is adopted and embraced. Kanter (1985) states that while the entrepreneurial management necessary to adopt change and the administrative management necessary to support sustaining operations may conflict, they are both necessary.

Kanter further asserts that technology has characteristics that require special management capabilities to deal with uncertainty, knowledge intensity, competition among alternative courses of action, and boundary crossing. To deal with these requirements, Kanter (1985) states that firms should stress visionary leadership, patient money, planning flexibility, team continuity/stability, and interfunctional cooperation.

Link and Tassey (1987) identify several additional organization issues related to research. Specifically, their study evaluates the research success of two categories of firms defined by Burns and Stalker (1961): organic and mechanistic. Organic structure firms possess more open decision-making channels and improved information flows. Conversely, firms structured mechanistically require a chain of authority for implementation that helps to ensure a one-way flow of information and effort. Specifically, Link and Tassey determine that firms with an organic structure are much more successful when pursuing what they term as "fundamental R&D" than are firms classified as mechanistic.

CHAPTER III. RESEARCH MODEL

This chapter develops a model that depicts the relationships between the elements of technology, the culture and strategy of the organization, the external environment, the perspective of the decision makers, and the economic performance of the firm. It then identifies the objectives of this research as well as hypotheses to be tested.

Model

From the previously discussed literature on technology, the relationships between the three elements of technology can be depicted as shown in Figure 1. Note the serial relationship between the three elements, with the output of each element serving as input to a successive one. (Note that the block labelled "Selection of Research Areas" represents all activities from the selection of research areas for investment through actually performing the research.)

The answer to Maidique and Patch's first question germane to the selection of research areas (i.e., what technologies are promising from the perspective of the existing or anticipated new product line?) is termed "internal technological fit." Figure 2 depicts the role of this criterion as a filter. In this perceptual filter, decision makers attempt to evaluate the match between research areas and their perception of the organization's strategy and culture. In addition to assisting in the determination of the internal technological fit of research areas, the model shows that the organization's strategy and culture also influence the development of research results, the engineering of the technology to the specific requirements of the firm, and the acceptance of the technology during implementation. For example, strategy and organization culture might impact both the manner in which an organization perceives risk (e.g., a requirement for a higher degree of internal technological fit of research areas might

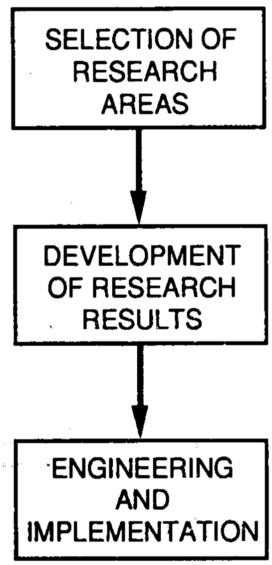

Figure 1. The Relationship Between the Components of Technology

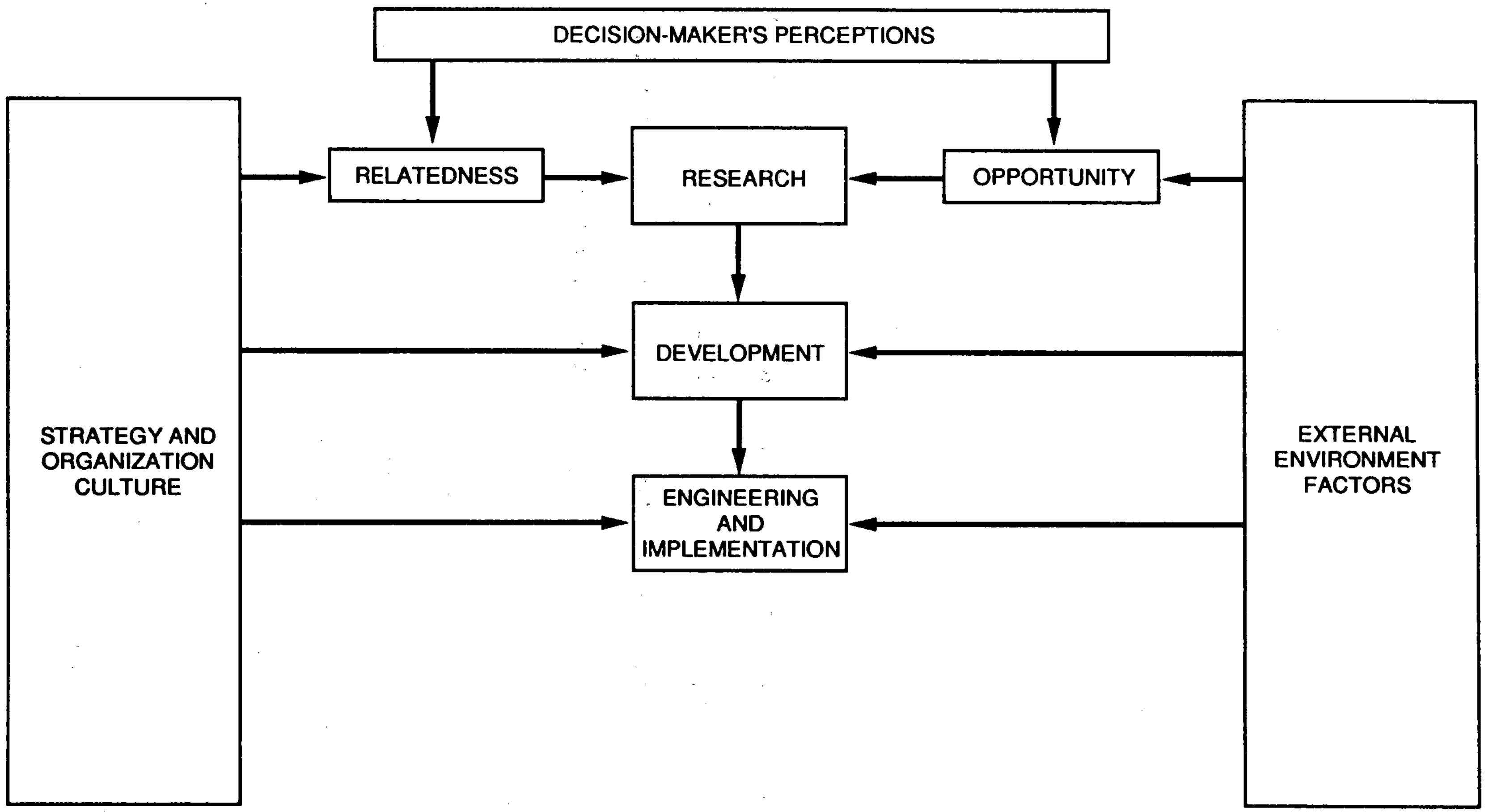

Figure 2. Technology Elements Affected by Organization Culture and the External Environment

be expected of firms with a low propensity for risk) and the environment in which the results of research are developed, engineered, and implemented (e.g., organization culture might cause a reluctance to adopt new technologies).

Similarly, the answer to Maidique and Patch's second question (what technologies provide potential for improved product performance or lower product costs?) is termed "external market opportunity." The external market opportunity factor is represented in the model (see Figure 2) as a perceptual filter that attempts to evaluate the match between opportunities in the external environment and research areas. Considered as part of the external environment are conditions such as the general economic climate outside of the firm and the amount of investment capital available. Because the ability to effectively control these variables in real situations is limited, this study will moderate the impact of variations in this factor by sampling within a single industry and over a constant, finite time period.

It should be stated here that it is not the actual internal technological fit or external market opportunity of the research area which influences the decision-maker's preference for a research area but, rather, the decision-maker's perception of the degree of external market opportunity and internal technological fit. Thus, decision makers with a basis for perceiving things in a consistent manner, such as those decision makers possessing Ph.D. degrees, should perceive external market opportunity and internal technological fit in a similar manner.

Figure 3 shows the proposed model for relating the selection of research areas to economic performance after incorporating the ideas reviewed in the section "Assessing the Effectiveness of Technology." Thus, the effectiveness of a firm's ability to select research areas can and will be evaluated with respect to a measure of business economic performance. (Note that the effects of industry forces will be moderated by sampling within one industry.)

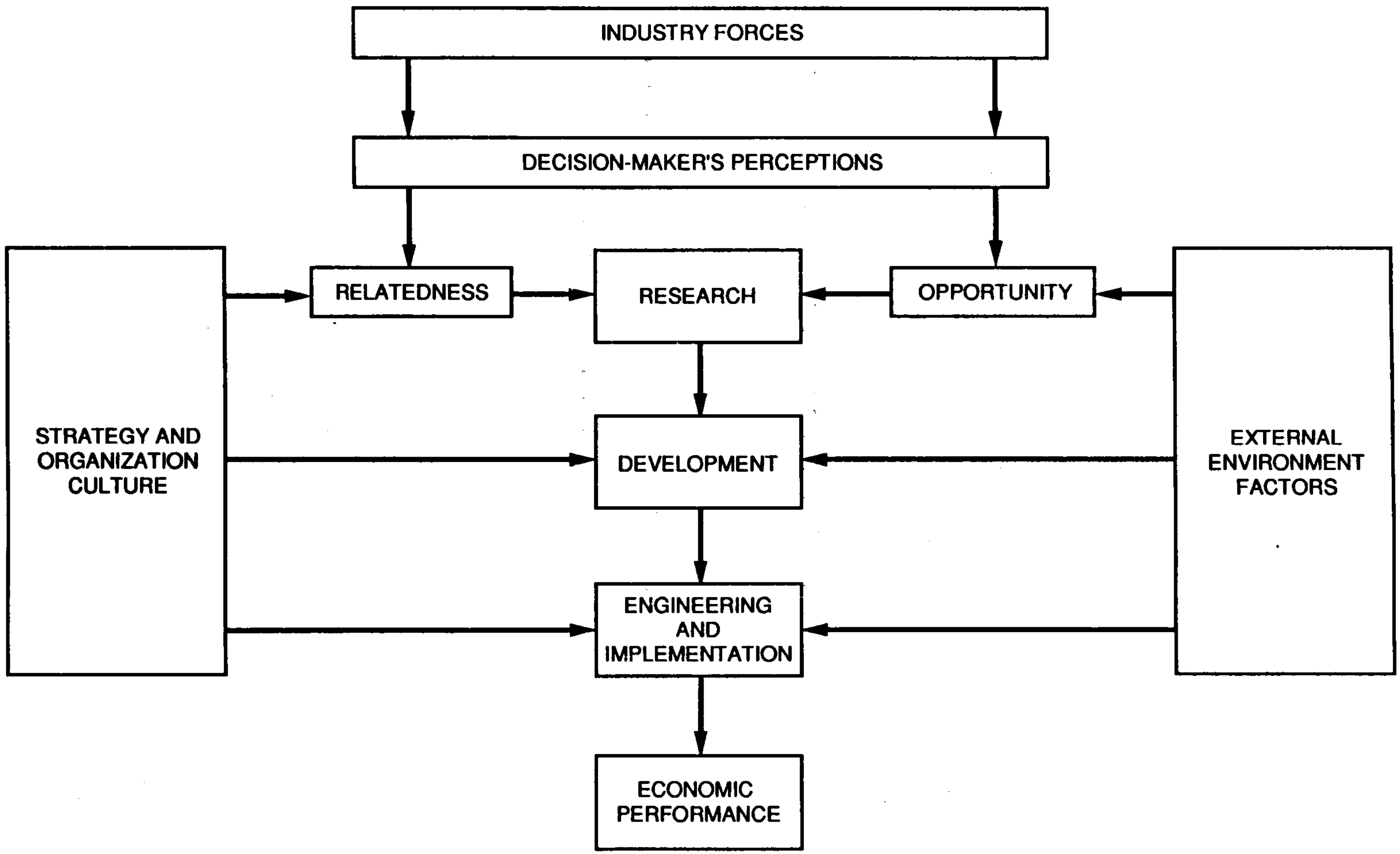

Figure 3. Relationship Between Selection of Research Areas and Business Economic Performance

Objectives

The first objective of this research was to verify that the two research area selection decision criteria were not weighted equally by decision makers and that decision makers themselves do not fully realize the basis by which they select research areas. The two decision criteria studied were those identified by Maidique and Patch (1988), namely external market opportunity and internal technological fit. Associated with each of these two factors are two values. The first value is the decision-makers' stated importance of the factor. This value is obtained by asking the decision maker to state the importance of the factor to the research area selection process. The second value is the actual importance of the factor as determined by regressing the attractiveness each decision maker assigned to the various research areas against the levels of external market opportunity and internal technological fit possessed by the areas. Specifically, the first group of subobjectives is as follows.

Objective 1a: Verify that, when selecting research areas, the decision-maker's stated importance of the external market opportunity factor differs from the decision-maker's stated importance of the internal technological fit factor.

Objective 1b: Verify that, when selecting research areas, the actual importance decision makers place upon the external market opportunity factor differs from the actual importance decision makers place upon the internal technological fit factor.

Objective 1c: Verify that, when selecting research areas, the decision-maker's stated importance of the external market opportunity factor differs from the actual importance decision makers place upon the external market opportunity factor.

Objective 1d: Verify that, when selecting research areas, the decision-maker's stated importance of the internal technological fit factor differs from the actual importance decision makers place upon the internal technological fit factor.

The second objective was to determine if the importance placed upon the internal technological fit and external market opportunity factors when selecting research areas was equivalent for decision makers grouped by their perception of their business's basis for competing. For example, the importance placed upon internal technological fit may be higher for decision makers who perceive that their firm is competing on the basis of price as they seek opportunities for efficient operations. The second group of subobjectives follows.

Objective 2a: Determine if either the stated or actual importance of the external market opportunity factor varies significantly with the decision-maker's perception of the firm's basis for competing (i.e., price versus product differences).

Objective 2b: Determine if either the stated or actual importance of the internal technological fit factor varies significantly with the decision-maker's perception of the firm's basis for competing (i.e., price versus product differences).

The third objective was to determine if the relative weights placed upon the internal technological fit and external market opportunity factors when selecting a research area were correlated with the educational background of the decision maker. The literature reviewed indicates that persons possessing a Ph.D. degree approach decision making in a fairly consistent manner. Furthermore, a person with a Ph.D. degree is considered to be knowledgeable of the principles of research. The third group of subobjectives follows.

Objective 3a: Determine if the actual importance of the external market opportunity factor varies significantly between decision makers possessing Ph.D. degrees and those not possessing Ph.D. degrees.

Objective 3b: Determine if the actual importance of the internal technological fit factor varies significantly between decision makers possessing Ph.D. degrees and those not possessing Ph.D. degrees.

The fourth objective was to examine the relationship between the relative weights of the two decision criteria and the economic performance of the business.

Objective 4: Determine the relationship that exists between business economic performance and the importance of each research area selection factor (i.e., external market opportunity and internal technological fit).

The fifth and final objective was to examine the difference in relative and subjective weight for each of the two factors (a difference to be referred to as insight into the basis for decisions) and its relationship to business economic performance. (Note that smaller values are associated with better insight.) To meet this objective, the arithmetic difference between the decision-maker's subjective weight of each factor and his/her relative weight of each factor will be correlated with the business economic performance indicators.

Objective 5: Analyze the relationship between the business economic performance and the decision-maker's insight into the importance of the two research area selection factors.

Hypotheses

In this section, observations and general hypotheses are stated. Following each general hypothesis are associated alternative hypotheses. However, tested in all cases were the corresponding null hypotheses. Note that individual alternative hypotheses are each uniquely numbered following the prefix "HA". The null hypotheses which were tested are listed in Chapter V and are each uniquely numbered following the prefix "HO". (Additional discussion of the hypotheses may be found in Chapter V.)

Observation: Many corporate-level strategic decisions have been modelled in past studies. For example, studies have been performed on acquisition decisions (Stahl and Zimmerer, 1984) and joint venture decisions (Porterfield, 1986). In these studies significant differences were discovered between the subjective and relative weights of the decision criteria.

These studies, which were all documented by Stahl (1989), have shown that strategic decision makers are sometimes unaware of the importance they give to key variables when making decisions. Specifically, it has been shown that a significant difference may exist between the actual importance (i.e., relative weight) placed on the two factors, the mean stated importance (i.e., subjective weight) of the two factors, and, the mean stated and mean actual importance of each factor.

Maidique and Patch (1988) theorize that the selection of research areas for investment should be based upon two decision criteria, namely internal technological fit and external market opportunity. Maidique and Patch, who refer to the two decision criteria simply as relatedness and opportunity, state that the relatedness criteria is a measure of how applicable a research area is to existing or anticipated products, while the opportunity criteria is a measure of the potential of the research area to have a positive impact in the market.

Similar to these previous decision-modelling studies, it is believed that decision makers selecting research areas are often unaware of the importance they are placing upon the external market opportunity and internal technological fit decision criteria. Thus, it is hypothesized that a difference will be found (1) between the factors at the mean stated levels of importance, (2) between the factors at the mean actual levels of importance, and (3) between the stated and actual importance of each factor.

General hypothesis: The subjective and relative weights placed upon the research area selection criteria are different.

HA1: When selecting research areas, the mean subjective weight that decision makers place on the external market opportunity factor differs significantly from the mean subjective weight that decision makers place on the internal technological fit factor.

HA2: When selecting research areas, the mean relative weight that decision makers place on the external market opportunity factor differs significantly from the mean relative weight that decision makers place on the internal technological fit factor.

HA3: When selecting research areas, the mean subjective weight that decision makers place on the external market opportunity factor differs significantly from the mean relative weight that decision makers place on the external market opportunity factor.

HA4: When selecting research areas, the mean subjective weight that decision makers place on the internal technological fit factor differs significantly from the mean relative weight that decision makers place on the internal technological fit factor.

Observation: Porter (1985) has identified two primary bases for competing in a competitive market, namely either offering a lower price or offering a favorably differentiated product. Porter also asserted that firms should select one of these bases for competing and that all of the strategic decisions made by the firm should complement the selected basis for competing. Furthermore, Dess and Davis (1984) have shown that firms can be effectively grouped into firms which emphasize low price as their primary competitive basis and those which emphasize product differences as their primary competitive basis.

Thus, it is expected that, based upon Porter's assertion that decisions should complement the firm's primary basis for competing, decision makers whose firms are classified as emphasizing low price as a competitive decision will place a different level of importance upon the research area selection factors than will decision makers whose firms are classified as emphasizing product differentiation as the primary competitive basis.

This belief is supported by much of the literature reviewed in Chapter II, especially Ansoff (1984) and Porter (1985), which state that all strategic decisions should be consistent with each other and that decision makers who perceive their firm is competing on the basis of low price should desire to invest in research areas that are promising from a cost reduction, or efficiency, standpoint. Correspondingly, decision makers who perceive that their firm is competing on the basis of product differences will desire to invest in research areas that present an external market opportunity.

Maidique and Patch (1988) have stated that the two factors of importance when selecting research areas for investment are relatedness (i.e., internal technological fit) and opportunity (i.e., external market opportunity). The internal technological fit of a research area is a measure of its applicability to existing products or anticipated products. Hence, it is expected that firms which emphasize low price as their primary basis for competing will both, state (i.e., subjective weight) and place (i.e., relative weight), more importance upon the research area selection factor of internal technological fit because they desire to increase the efficient use of the resources they possess.

General hypothesis: Firms which compete on the basis of low price desire efficiency and, therefore, place more emphasis upon the internal technological fit factor. Consequently, firms which compete on the basis of product differentiation place more emphasis on external market opportunity than do decision makers whose firms compete on the basis of low price.

HA5: When selecting research areas, the mean subjective weight placed upon the external market opportunity factor by decision makers whose firms are competing on the basis of price is less than the mean subjective weight placed upon the external market opportunity factor by decision makers who perceive that their firm is competing on the basis of product differentiation.

HA6: When selecting research areas, the mean relative weight placed upon the external market opportunity factor by decision makers who perceive that their firm is competing on the basis of price is less than the mean relative weight placed upon the external market opportunity factor by decision makers who perceive that their firm is competing on the basis of product differentiation.

HA7: When selecting research areas, the mean subjective weight placed upon the internal technological fit factor by decision makers who perceive that their firm is competing on the basis of price is greater than the mean subjective weight placed upon the internal technological fit factor by decision makers who perceive that their firm is competing on the basis of product differentiation.

HA8: When selecting research areas, the mean relative weight placed upon the internal technological fit factor by decision makers who perceive that their firm is competing on the basis of price is greater than the mean relative weight placed upon the internal technological fit factor by decision makers who perceive that their firm is competing on the basis of product differentiation.

Observation: Maslow (1965) recognized that scientists often possess similar characteristics with respect to motivation and personality. Other researchers, such as Mendelsohn, Roe, Saunders, Siepert, Kaplan and Shepard (1963) have studied the different manner in which scientists approach research. In yet another study, decision makers possessing Ph.D. degrees, based upon their knowledge of research, were shown to have a different perception of research risk (Eiduson, 1962).

In addition, Maidique and Patch (1988) theorize that the selection of research areas for investment should be based upon two decision criteria, namely internal technological fit and external market opportunity. Maidique and Patch, who refer to the two decision criteria simply as relatedness and opportunity, state that the relatedness criteria is a measure of how applicable a research area is to existing or anticipated products, while the opportunity criteria is a measure of the potential of the research area to have a positive impact in the market. Hence, internal technological fit may be thought of as the degree of closeness of a research area to the expertise the firm currently possesses. Thus, a research area with a high degree of internal technological fit is hypothesized to be perceived by the decision maker who possesses a Ph.D. degree as less risky.

Therefore, it is believed that, due to a combination of their understanding of the research process, their comfort in performing research related to their area of expertise and a generally different perception of research risk, decision makers with Ph.D. degrees will actually place different importance on the internal technological fit criterion than will decision makers who do not possess Ph.D. degrees.

General hypothesis: Decision makers who possess a Ph.D. degree actually place less importance upon the external market opportunity and more importance upon the internal technological fit criteria than do decision makers who do not possess a Ph.D. degree. This is due to the facts that persons possessing Ph.D. degrees have a different perception of research risk, and persons possessing Ph.D. degrees possess an interest in a specific stream of research.

HA9: The mean relative weight placed upon the external market opportunity factor by decision makers with a Ph.D. degree is less than the mean relative weight placed upon the external market opportunity factor by decision makers without a Ph.D. degree.

HA10: The mean relative weight placed upon the internal technological fit factor by decision makers with a Ph.D. degree is greater than the mean relative weight placed upon the internal technological fit factor by decision makers without a Ph.D. degree.

Observation: Technology has been reported to be associated with the economic success of many firms (Fusfeld and Langlois, 1982). This may occur because, as asserted by Porter (1985), technology can alter the competitive advantage enjoyed by members of an industry.

Furthermore, Willard and Cooper (1985) have stated that technology can actually alter the balance of power of the competitive forces within an industry.

Maidique and Patch (1988) theorize that the selection of research areas for investment should be based upon two decision criteria, namely internal technological fit and external market opportunity. It is hypothesized that the economic performance indicators may vary in accordance with the weight placed upon the research area selection factors. Thus, the data should reflect a correlation between business economic performance indicators (i.e., sales growth, return on investment and net income growth) and the importance placed upon the criteria in the research area selection process.

Even more specifically, firms which place a large amount of importance upon the internal technological fit factor are believed to be interested in efficiently utilizing their resources. Thus, it is logical that the importance placed upon internal technological fit, which may be associated with a reduction in investment capital required, should be positively correlated with the firm's return on investment.

General hypothesis: The actual weights placed upon the selection criteria are correlated with the economic performance of the firm.

HA11: The business economic performance indicators are not correlated with the subjective weight that decision makers place on the external market opportunity factor.

HA12: The business economic performance indicators are not correlated with the subjective weight that decision makers place on the internal technological fit factor.

HA13: The business economic performance indicators are not correlated with the relative weight that decision makers place on the external market opportunity factor.

HA14: The business economic performance indicators are not correlated with the relative weight that decision makers place on the internal technological fit factor.

Observation: Slovic and Lichtenstein (1971) used a measure termed "insight" to evaluate the degree to which decision-makers understand the importance of factors to a decision process. Slovic and Lichtenstein concluded that persons who understand the importance to attribute to the decision criteria are able to make better decisions than other decision makers. This is consistent with the later conclusions of Schilit and Paine (1988). Furthermore, many of the studies documented by Stahl (1989) concern the insight of decision-makers and its impact upon the effectiveness of the decision process.

Decision makers who do not have insight are believed to select research areas for investment based more upon instinct and "gut feelings" than upon decision criteria. Hence, it is believed that decision makers who understand the basis upon which they select research areas for investment actually have a more positive impact upon their firm's performance than do decision-makers who do not.

General hypothesis: Smaller differences in subjective and relative weights of factors are typical of firms with insight and are, therefore, correlated with higher performing firms.

HA15: The insight of decision makers into the importance of the external market opportunity factor is positively correlated with the business economic performance indicators.

HA16: The insight of decision makers into the importance of the internal technological fit factor is positively correlated with the business economic performance indicators.

CHAPTER IV. METHODOLOGY

Chapter III includes a process model of technology implementation which begins with the selection of research areas for investment and which concludes with the performance of the firm being altered. The model hypothesizes that after a research area is selected, the research will be performed and new knowledge will be discovered that feeds the subsequent components of technology. The model further depicts that implementation of the technology occurs after engineering the technology to the specific requirements of the firm. Finally, the model hypothesizes that the economic performance of the firm is altered. Note that the necessary initiating event of the entire technology implementation process is the selection of research areas, the focus of this study.

This chapter is divided into sections that discuss the variables and measures, research design, sources of data, target industry, and planned methods of analysis. The instrument used to collect the data analyzed is included as Appendix A.

Variables and Measures

To accomplish the previously stated objectives and to test the stated hypotheses, the following terms were defined and measured as follows.

business economic performance - Venkatraman and Ramanujam (1987) utilize three perceptual measures of a firm's ability to compete as measures of business economic performance: sales growth, return on investment, and net income growth. Similarly, the business economic performance in the present study was measured via a perceptual ranking by the decision makers of the position of their business relative to its major competitors. As in Venkatraman and Ramanujam's research, a five-point interval scale ranging from -2 (much worse than competitors) to +2 (much better than competitors), with the neutral point of 0 (approximately the same as competitors), was employed.

external market opportunity - One of the independent variables in this research, external market opportunity, was defined by Maidique and Patch (1988) as the degree to which a research area appears to have potential to improve product performance or lower product costs. The external market opportunity variable was experimentally manipulated as an independent variable and assigned the comparative value of either high, medium, or low. (This variable is often referred to simply as "opportunity.")

internal technological fit - The second independent variable in this research, internal technological fit, was defined by Maidique and Patch (1988) as the degree to which a research area appears promising from the perspective of existing or anticipated products. The internal technological fit variable was experimentally manipulated as an independent variable and assigned the comparative value of either high, medium, or low. (This variable is sometimes referred to simply as "relatedness.")

competitive basis - Porter (1985) identifies two primary bases for competing: price and product differentiation. As in the work by Davis and Dess (1984), factor analysis was used to place the firms of all decision-makers into one of these strategic groups of firms based upon the decision-maker's assessment of the importance of 21 strategic variables to their firm's performance. The decision-makers used a scale which ranged from 1 (not important at all) to 5 (extremely important) to evaluate each variable. As in the work by Dess and Davis, firms were grouped based upon the consistency between the decision-maker's stated importance of each of the variables to their firm and the academicians assessment of the importance of each variable to each of the bases for competing.

Ph.D. degree - This classifying variable was used as a binary variable by which the data was categorized on the basis of the decision-makers' educational background (i.e., holders of Ph.D. degrees and nonholders of Ph.D. degrees). All decision makers were asked to list the degrees they possess.

research area attractiveness - The degree to which a research area is supported as an area in which to invest funds for research. This dependent variable was measured as in the studies by Stahl (1989) and was collected via the responses to a 10-point interval scale ranging from 0 (strongly recommend not funding) to 10 (strongly recommend funding), with 5 as the point representing no strong feelings toward funding or not funding.

insight - As defined and measured by Slovic and Lichtenstein (1971), insight is the absolute value of the mathematical difference between the stated importance of a decision criterion and the actual importance the decision maker places on the decision criterion. The stated importance of the decision criteria was obtained from the decision-maker's assessment of the importance of one criterion to the other. The actual importance of both decision criteria was determined by modelling the decision-makers' responses to the data collection instrument.

Research Design

Because the data were collected on two factors with three possible levels each, the resulting research design is 3×3. Thus, the data were collected per the 3×3 matrix shown in Table 3. Note that the two factors were assigned comparative levels as in the work by Stahl (1988). Thus, each case represents a unique combination of the internal technological fit factor and the external market opportunity factor.

Table 3. Internal Technological Fit versus External Market Opportunity

		External Market Opportunity Level		
		Low	*Medium*	*High*
Internal Technological Fit Level	*Low*	Case 9	Case 6	Case 3
	Medium	Case 8	Case 5	Case 2
	High	Case 7	Case 4	Case 1

As in Dess and Davis (1984), firms which utilize a strategy based upon cost leadership emphasize a certain group of strategic variables while those emphasizing product differences emphasize another. Thus, the grouping of the data with respect to firms which utilize price or product differences was determined via a strategic grouping of the decision-makers' responses to the importance of 21 strategic variables to their firms performance.

Whether or not a decision maker possessed a Ph.D. degree was determined via an introductory question (i.e., decision makers possessing the Ph.D. degree were self-identified).

Pilot Test of Questionnaire

Two areas of concern were addressed by performing a pilot test of the data collection instrument (i.e., questionnaire). The first area of concern involved the obtrusiveness of the data collection instrument. Verification of the time required to complete the questionnaire was accomplished through a pilot test of the instrument utilizing managers at the Oak Ridge National Laboratory (ORNL). Of the 20 ORNL managers asked to participate, responses were received from 14. The mean time required to complete the questionnaire was 12.1

minutes, and no manager required more than 27 minutes. Thus, the pilot test alleviated the concern with the time required to complete the questionnaire.

The second area of concern regarding the data collection instrument, involved the ability of the decision makers to consistently base their decisions upon the two factors. This second area of concern was also addressed by analyzing the within rater consistency of the ORNL decision makers. This area of concern was alleviated by a minimum within rater R^2 of 0.72 and a maximum within rater R^2 of 0.96 for decision makers in the pilot test.

Sources of Data

Data to be analyzed were obtained from managers involved in the selection of research areas. (Appendix A contains the instrument that was used to collect the data for analysis while Appendix B identifies the distribution to which the questionnaire was sent.) Part I of the questionnaire contains the decision-maker's stated importance of the two factors to the research area selection process, the decision-maker's assessment of their firm's economic performance, the decision-maker's assessment of the importance of 21 variables to the success of their organization, and, the decision-maker's assessment of the attractiveness of nine research areas possessing varying levels of external market opportunity and internal technological fit.

Part II of the instrument requested information which was believed might be useful in explaining part of the variance in the data. However, the only data from Part II of the instrument which was used in the testing of hypotheses was whether or not the decision maker possessed a Ph.D. degree .

Target Industry

As previously stated, this dissertation analyzes data from a single industry in an attempt to minimize noise caused by the market forces. Specifically, the data for this dissertation were obtained from decision makers in the pharmaceutical preparation industry. Some key characteristics of the pharmaceutical preparation industry that enhance its appeal for use in this study follow.

1. Research within the pharmaceutical preparation industry is common. Furthermore, and as stated in the Value Line Investment Survey (1991), performance in this industry is known to be related to successes in research. Prospects for continued investment in research are excellent.
2. Research is currently being performed in multiple areas (e.g., microbiology, chemotherapy, cancer, Acquired Immune Deficiency Syndrome). Therefore, decision makers are typically faced with decisions related to selecting research areas for investment.
3. Products within the industry may successfully compete on the basis of either price (e.g., generic label drugs) or product differences (e.g., faster pain relief). This should increase the probability of obtaining the required distribution of responses to test the hypotheses dealing with the decision-maker's perception of their firm's chosen competitive basis.
4. Many companies within the industry are organized in a manner consistent with strategic business unit identity (e.g., prescription drugs, over-the-counter drugs, generic drugs). This will permit acquiring multiple responses per business.

5. Based upon the distribution of persons being requested to participate (see Appendix B), a good distribution of decision makers possessing Ph.D. degrees to those not possessing Ph.D. degrees was anticipated.

Executives from firms which listed standard industrial classification code 2834 (i.e., pharmaceutical preparation) as their primary business and which have a net worth of more than $500,000 were asked to participate. These firms are identified in Appendix B.

Sampling Procedure

238 questionnaires were mailed to key decision makers (e.g., CEOs, VPs of R&D, etc.) in the pharmaceutical preparation industry. Responses, which were requested to be returned within 1-month of receipt, were received from 92. Actions taken to ensure receiving an acceptable response rate (pre-defined as greater than 20%) included the following: (1) a follow-up phone call was made to each addressee, (2) addressees were allowed to return their completed questionnaire by FAX (thus enhancing the convenience of responding), (3) a token gift was included in the mailing of the questionnaire, (4) the study was applicable to the decision-makers' responsibilities, and (5) a promise was made to provide each participant with a summary page of the results. Of the 92 responses received, 39 declined to participate. The most common reason cited for declining was that participation in surveys violates company policy.

Methods of Analysis

The intent of this research was not to deduce some formula by which selection of research areas is reduced to a mere calculation. Rather, it was to relate the research area selection patterns of business with the impact of those decisions. To accomplish this, the decision makers completed a decision-making exercise wherein they (1) stated their perception of the importance of the two research area selection factors and (2) assessed the attractiveness of research areas that possess varying levels of those two factors.

Two regression models were constructed. In the first regression model, the subjective weight (SW) of external market opportunity, the SW of internal technological fit, the relative weight (RW) of external market opportunity, the RW of internal technological fit the Ph.D. variable, the insight of internal technological fit, the insight of external market opportunity, and the competitive basis variable were regressed upon the business economic performance variable. The second regression model is identical except that the SW of external market opportunity and the SW of internal technological fit were excluded.

The mathematical model used by Stahl (1989) was utilized. In this model, the subjective weights are based entirely upon the decision-maker's stated importance of each factor to the research area selection process. The decision-maker's relative weight for each factor is calculated based upon the decision-maker's assessment of the attractiveness of research areas possessing varying levels of each factor.

Specifically, the relative weight was obtained from an analysis of actual decisions and is calculated mathematically. The relative weight is the actual importance placed upon each variable in the decision-making process. The results of decisions were modelled, and the relative weight of the factor was calculated as the standardized regression coefficient of the variable divided by the square of the multiple correlation coefficient, or

$$RW_i = \frac{B_i^2}{R^2}$$

and

$$Y_j = B_1 (X_{ij}) + B_2 (X2_j) + ... + B_i (X_{ij}) ,$$

where i = the number of variables,

j = the number of research areas considered,

Y_j = the value of the decision,

X_{ij} = the normalized value for variable i of candidate j,

B_i = the standard regression coefficient or importance attributed to variable i,

R = the multiple correlation coefficient.

The data were grouped and analyzed with respect to three categories: all data within the industry, whether the decision maker possesses a Ph.D. degree, and the primary competitive basis used by the firm. The first two of these groupings were accomplished without special analyses.

To segment the data with regard to competitive basis, of primary importance was distinguishing which firms emphasized low price from those firms that emphasized product differentiation. Similar to the previous work by Dess and Davis (1984) wherein firms which utilized the differentiation strategy were classified appropriately ($p=0.001$), the firms were classified on the basis of the decision makers' assessments of the importance of 21 competitive variables. The decision makers' assessments of the importance of the 21 variables were compared to the importance academicians (Dess and Davis, 1984) stated the variables have for firms competing on low price and on product differentiation. Note that the firms of decision makers whose responses did not clearly align with either category of low price or product differentiation are considered "stuck in the middle" (i.e., committed to neither of the strategies). Firms which are stuck in the middle are not believed to place any consistent importance upon decision criteria because they are not committed to either strategy. This inconsistency may be related to many unknown factors. Therefore, the data from firms classified as stuck in the middle were excluded from any tests wherein it was necessary to distinguish between firms pursuing low price strategies and firms pursuing differentiation strategies because those firms are not believed to be committed to either strategy.

Table 4 summarizes the grouping of the data and the statistical tests utilized by each hypothesis.

Table 4. Test Statistics and Data Manipulation Performed To Test 16 Hypotheses

Hypotheses	*Test Statistic*	*Data Manipulation Utilized*
HO1, HO2, HO3, HO4	paired t-test	All data were used in testing these hypotheses.
HO5, HO6, HO7, HO8	pooled t-test	The basis for competing emphasized by the decision maker's firm was determined by grouping firms on the basis of the decision maker's stated importance of 21 competitive variables.
HO9, HO10	pooled t-test	Decision makers were grouped based on their response to the query regarding whether they had earned a Ph.D. degree.
HO11, HO12, HO13, HO14	pooled t-test	All data were used in testing these hypotheses. Three separate regression models were evaluated using the three various measures of business economic performance [i.e., return on investment (ROI), net income growth, sales growth] as the independent variable.
HO15, HO16	paired t-test	Insight was calculated for each decision maker as the absolute value of the difference between the stated subjective weight and the calculated relative weight for each of the two primary factors.

CHAPTER V. DATA ANALYSES

This chapter discusses the analysis and interpretation of the data gathered from decision makers in the pharmaceutical industry. This chapter is comprised of subsections which provide a summary of the responses to the data collection questionnaire, a discussion of data manipulation techniques employed during data analyses, results of the testing of hypotheses, and a regression model in which the variables studied are regressed against the economic performance of the decision-maker's firm.

Summary of Responses

This section of Chapter V also summarizes some germane demographic data on the 53 respondents (22% of addressees) who chose to participate. Recall that some of the hypotheses tested required grouping decision makers with respect to certain attributes. Among the decision-maker attributes of significance were (1) whether or not the decision maker possesses a Ph.D. degree and (2) whether or not the decision-maker's firm emphasizes price or product differences as a basis for competing in the market. The distribution of responses received with respect to these areas is listed in Table 5.

Note that the determination of whether a firm emphasizes low price or product differentiation was accomplished via a strategic grouping of the decision-makers' stated importance of 21 competitive variables to their firms success. A summary table of factor loadings is given in Table 6 and the resulting strategic grouping is depicted graphically in Figure 4. Note that the 10 decision makers whose responses to the importance of the 21 strategic variables did not clearly distinguish their firm as emphasizing either low price or product differentiation are represented in the figure by triangles. Furthermore, these 10 were

Table 5. Distribution of Responses By Germane Categories

Category	*Number Received*
Ph.D	21
Non-Ph.D.	32
Price	7
Product Differentiation	36
Stuck In The Middle	10

omitted from any analysis requiring segmentation of the data into competitive basis categories. Table 6 summarizes the loadings of the variables upon each competitive basis factor.

Table 6. Summary of Factor Loadings of Competitive Variables

Factor	*Variable*	*Loading*
Factor 1: Low Price	product quality control	0.66
	operating efficiency	0.58
	competitive pricing	0.58
	procurement of raw materials	0.56
	experienced/trained personnel	0.53
	innovation in manufacturing processes	0.50
Factor 2: Product Differentiation	brand identification	0.68
	new product development	0.67
	forecasting market growth	0.66
	advertising	0.59
	control of distribution channels	-0.48
	innovation in marketing techniques	0.40

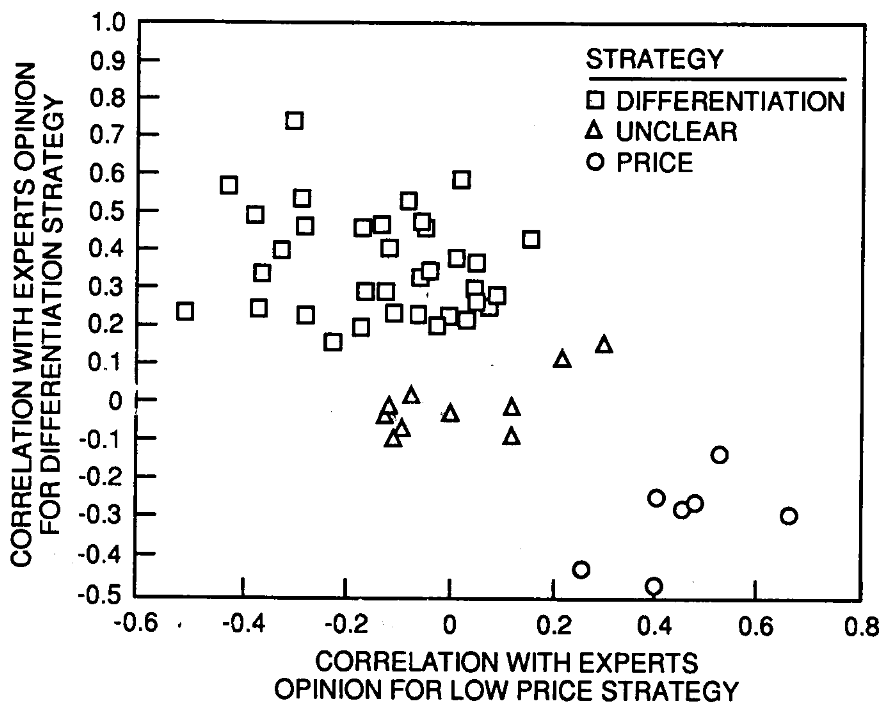

Figure 4. Strategic Grouping of Firms via Correlation with Experts on the Strategic Importance of 21 Competitive Variables

Data Manipulation

Prior to analysis, the consistency of responses for each decision maker was assessed. An internal consistency rating was calculated for each decision maker. The internal consistency measure (i.e., R^2) for each individual's regression equation simply assessed the degree of consistency in the decision-maker's logic. The minimum within rater R^2 was 0.76, which was well above the R^2 of 0.46 derived from testing the beta weights equal to zero (Stahl, 1989). The mean within rater R^2 for the 53 respondents was 0.93. Therefore, the decisions of all 53 respondents were modelled.

Table 7 presents some summary data representing all of the responses received. Specifically, Table 7 provides the mean within rater R^2, the mean subjective weights of the opportunity and relatedness factors, and the mean relative weights of the opportunity and relatedness factors. Note that, when selecting research areas, the mean importance decision makers in the pharmaceutical preparation industry actually place (i.e., relative weight) upon the external market opportunity factor is greater than the mean importance they place on the internal technological fit factor. Note that similar results were seen when the decision makers stated the importance of the two factors.

Data manipulation was required to segment the data with respect to two primary classification schemes, namely competitive basis (i.e., low price or product differentiation) and whether or not the decision maker had earned a Ph.D. degree. Determination of whether or not the decision maker possessed a Ph.D. degree was accomplished via direct inquiry. However, segmentation with respect to the emphasized competitive basis was more complex.

Table 7. Means* of Responses Received

Individual R^2	*Subjective Weight - Opportunity*	*Subjective Weight - Relatedness*	*Relative Weight - Opportunity*	*Relative Weight - Relatedness*
0.93	54.7	45.3	55.8	44.2

* n = 53

Tests of Hypotheses

In this section, the null hypotheses are stated and the corresponding test results listed and interpreted.

HO1: When selecting research areas, the mean subjective weight that decision makers place on the external market opportunity factor does not differ significantly from the mean subjective weight that decision makers place on the internal technological fit factor.

Discussion: This hypothesis is directed at determining whether or not the decision makers state that the two factors of interest, namely internal technological fit and external market opportunity, possess significantly different levels of importance (i.e., one factor is stated to be more important than the other in the selection of R&D Areas).

Results: Table 8 summarizes the data analyzed in evaluating this hypothesis.

Interpretation: Based upon the data summarized in Table 8 and at the 0.10 level of significance, sufficient evidence was not obtained to reject the null hypothesis. Thus, decision makers were not shown to state that the two R&D selection criteria possess significantly different levels of importance.

Table 8. Comparison of Mean Subjective Weight for Opportunity and the Mean Subjective Weight for Relatedness

Variable	*Mean (sd)*	*t-value**	*Pr>t (2-tail)*
SW-Opportunity	54.7 (20.1)	1.68	0.10
SW-Relatedness	45.3 (20.1)		

* n = 53

HO2: When selecting research areas, the mean relative weight that decision makers place on the external market opportunity factor does not significantly differ from the mean relative weight that decision makers place on the internal technological fit factor.

Discussion: This hypothesis is directed at determining whether or not the decision makers actually place significantly different levels of importance upon the two factors of interest, namely internal technological fit and external market opportunity when selecting R&D Areas for investment.

Results: Table 9 summarizes the data analyzed in evaluating this hypothesis.

Table 9. Comparison of Mean Relative Weight for Opportunity and the Mean Relative Weight for Relatedness

Variable	*Mean (sd)*	*t-value**	*Pr>t (2-tail)*
RW-Opportunity	55.8 (27.0)	1.55	0.13
RW-Relatedness	44.2 (27.0)		

* n = 53

Interpretation: Based upon the data presented in Table 9 and at the 0.10 level of significance, sufficient evidence was not obtained to reject the null hypothesis. Thus, decision makers were not shown to place a significantly different level of importance on the two R&D selection criteria.

HO3: When selecting research areas, the mean subjective weight that decision makers place on the external market opportunity factor does not significantly differ from the mean relative weight that decision makers place on the external market opportunity factor.

Discussion: This hypothesis is intended to test for a significant difference between the stated importance of the external market opportunity factor and the actual importance placed upon the external market opportunity factor in the selection of R&D Areas for investment.

Results: Table 10 summarizes the data analyzed in evaluating this hypothesis.

Table 10. Comparison of Mean Subjective Weight for Opportunity and the Mean Relative Weight for Opportunity

Variable	*Mean (sd)*	*t-value**	*Pr>t (2-tail)*
SW-Opportunity	54.7 (20.1)	0.46	0.65
RW-Opportunity	55.8 (27.0)		

* n = 53

Interpretation: These data are presented graphically in Figure 5. Note that perfect agreement between relative weights and subjective weights would be represented by the points falling on a 45-degree line. At the 0.10 level of significance and based upon the data in Table 10,

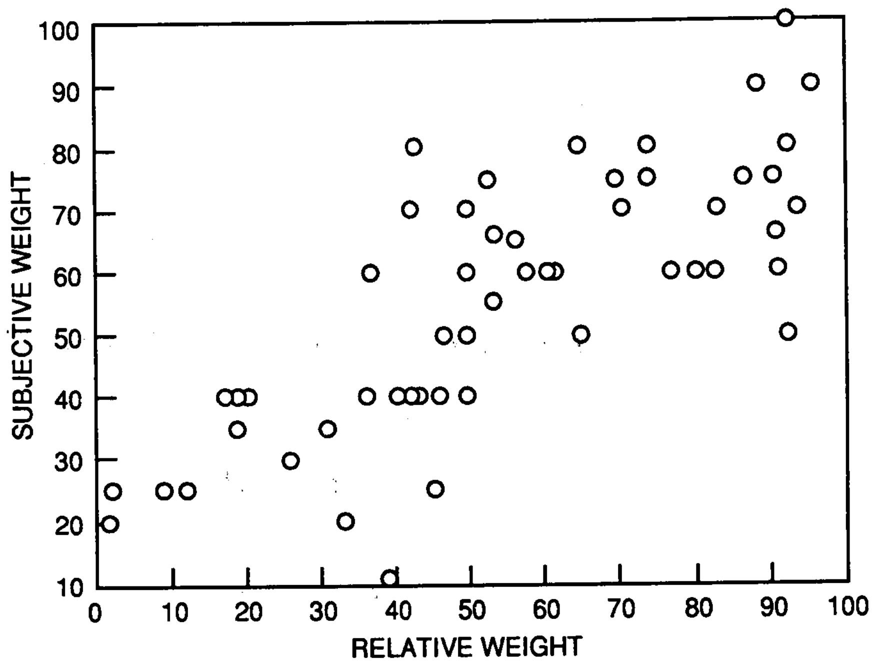

Figure 5. Comparison of the Subjective Weights for the External Market Opportunity Factor and the Relative Weights of the External Market Opportunity Factor (r=0.69)

insufficient evidence exists to reject the null hypothesis. Therefore, on the average, decision makers possess good insight of the importance of the external market opportunity factor to the R&D Area selection process. This can also be expressed by stating that the decision makers possess a high level of insight of the importance of the external market opportunity factor in the R&D Area selection process.

HO4: When selecting research areas, the mean subjective weight that decision makers place on the internal technological fit factor does not significantly differ from the mean relative weight that decision makers place on the internal technological fit factor.

Discussion: This hypothesis is intended to test for a significant difference in the stated importance of the internal technological fit factor and the actual importance placed upon the internal technological fit factor when selecting R&D Areas for investment.

Results: Table 11 summarizes the data analyzed in evaluating this hypothesis.

Table 11. Comparison of Mean Subjective Weight for Relatedness and the Mean Relative Weight for Relatedness

Variable	*Mean (sd)*	*t-value**	*Pr>t (2-tail)*
SW-Relatedness	45.3 (20.1)	-0.46	0.65
RW-Relatedness	44.2 (27.0)		

* n = 53

Interpretation: These data are presented graphically in Figure 6. Note that perfect agreement between relative weights and subjective weights would be represented by the points falling on a 45-degree line. At the 0.10 level of significance and based upon the data in Table 11, insufficient evidence exists to reject the null hypothesis. Therefore, on the average, decision makers possess good insight of the importance of the internal technological fit factor to the R&D Area selection process. This can also be expressed by stating that the decision makers possess a high level of insight of the importance of the internal technological fit factor in the R&D Area selection process.

HO5: When selecting research areas, the mean subjective weight placed upon the external market opportunity factor by decision makers who perceive that their firm is competing on the basis of price does not significantly differ from the mean subjective weight placed upon the external market opportunity factor by decision makers who perceive that their firm is competing on the basis of product differences.

Discussion: This hypothesis is intended to test for a significant difference in the stated importance of external market opportunity to the R&D Area selection process between decision makers whose firms emphasize product differences as a competitive strategy and decision makers whose firms emphasize low price as a competitive strategy.

Results: Table 12 summarizes the data analyzed in evaluating this hypothesis.

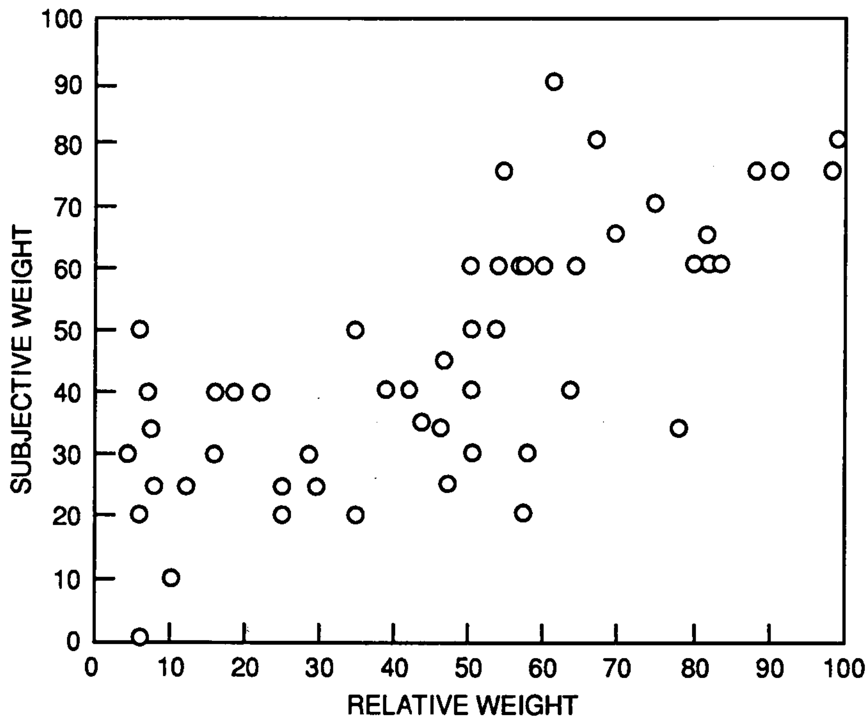

Figure 6. Comparison of the Subjective Weights for the Internal Technological Fit Factor and the Relative Weights of the Internal Technological Fit Factor (r=0.64)

Table 12. Comparison of the Mean Subjective Weight for Opportunity Assigned by Decision Makers Whose Firms Are Competing On Price and the Mean Subjective Weight for Opportunity Assigned by Decision Makers Whose Firms Are Competing On Product Differences

Variable	*Sample Population (n)*	*Mean*	*t-value**	*Pr>t (1-tail)*
SW-Opportunity	price (7)	40.7	1.93	0.03
SW-Opportunity	product differences (36)	57.1		

* n = 43 (Note that the 10 firms designated "stuck-in-the-middle" are excluded.)

Interpretation: The 10 firms categorized as stuck-in-the middle, were excluded from this analysis in order to compare two strategic groups against each other. At the 0.03 level of significance, the null hypothesis is rejected. When selecting R&D Areas for investment, the average difference in the stated weight of the external market opportunity factor between decision makers whose firms are competing on the basis of low price and decision makers whose firms are competing on the basis of product differentiation is significantly different from zero.

HO6: When selecting research areas, the mean relative weight placed upon the external market opportunity factor by decision makers who perceive that their firm is competing on the basis of price does not significantly differ from the mean relative weight placed upon the external market opportunity factor by decision makers who perceive that their firm is competing on the basis of product differences.

Discussion: This hypothesis is intended to test for a significant, actual difference in importance placed upon the R&D Area selection factor of external market opportunity between decision makers whose firms emphasize product differences as a competitive strategy and decision makers whose firms utilize low price as a competitive strategy.

Results: Table 13 summarizes the data analyzed in evaluating this hypothesis.

Table 13. Comparison of the Mean Relative Weight for Opportunity Assigned by Decision Makers Whose Firms Are Competing On Price and the Mean Relative Weight for Opportunity Assigned by Decision Makers Whose Firms Are Competing On Product Differences

Variable	*Sample Population (n)*	*Mean*	*t-value**	*Pr>t (1-tail)*
RW-Opportunity	price (7)	38.2	1.73	0.05
RW-Opportunity	product differences (36)	56.9		

* n = 43 (Note that the 10 firms designated "stuck-in-the-middle" are excluded.)

Interpretation: The 10 firms categorized as stuck-in-the middle, were excluded from this analysis in order to compare two strategic groups against each other. At the 0.05 level of significance, the null hypothesis is rejected. When selecting R&D Areas for investment, the average difference in the actual importance given to the external market opportunity factor between decision makers whose firms are competing on the basis of low price and decision makers whose firms are competing on the basis of product differentiation is significantly different from zero.

HO7: When selecting research areas, the mean subjective weight placed upon the internal technological fit factor by decision makers who perceive that their firm is competing on the basis of price does not significantly differ from the mean subjective weight placed upon the internal technological fit factor by decision makers who perceive that their firm is competing on the basis of product differences.

Discussion: This hypothesis is intended to test for a difference in the stated importance of internal technological fit to the R&D Area selection process between decision makers whose firms emphasize product differences as a competitive strategy and decision makers whose firms utilize low price as a competitive strategy.

Results: Table 14 summarizes the data analyzed in evaluating this hypothesis.

Table 14. Comparison of Mean SW-Relatedness for Decision Makers Whose Firms Are Competing On Price and Mean SW-Relatedness for Decision Makers Whose Firms Are Competing On Product Differences

Variable	*Sample Population (n)*	*Mean*	*t-value**	*Pr>t (1-tail)*
SW-Relatedness	price (7)	59.3	-1.93	0.03
SW-Relatedness	product differences (36)	42.9		

* n = 43 (Note that the 10 firms designated "stuck-in-the-middle" are excluded.)

Interpretation: The 10 firms categorized as stuck-in-the middle, were excluded from this analysis in order to compare two strategic groups against each other. The null hypothesis is rejected. When selecting R&D Areas for investment, the average difference in the stated importance of the internal technological fit factor between decision makers whose firms are competing on the basis of low price and decision makers whose firms are competing on the basis of product differentiation is significantly different from 0.

HO8: When selecting research areas, the mean relative weight placed upon the internal technological fit factor by decision makers who perceive that their firm is competing on the basis of price is not significantly different from the mean relative weight placed upon the internal technological fit factor by decision makers who perceive that their firm is competing on the basis of product differences.

Discussion: This hypothesis is intended to test for a significant, actual difference in importance placed upon the R&D Area selection factor of internal technological fit between decision makers whose firms emphasize product differences as a competitive strategy and decision makers whose firms utilize low price as a competitive strategy.

Results: Table 15 summarizes the data analyzed in evaluating this hypothesis.

Table 15. Comparison of the Mean Relative Weight for Relatedness Assigned by Decision Makers Whose Firms Are Competing On Price and the Mean Relative Weight for Relatedness Assigned by Decision Makers Whose Firms Are Competing On Product Differences

Variable	*Sample Population (n)*	*Mean*	*t-value**	*Pr>t (1-tail)*
RW-Relatedness	price (7)	61.8	-1.73	0.05
RW-Relatedness	product differences (36)	43.1		

* n = 43 (Note that the 10 firms designated "stuck-in-the-middle" are excluded.)

Interpretation: The null hypothesis is rejected. When selecting R&D Areas for investment, the average difference in the actual importance placed on the internal technological fit factor between decision makers whose firms are competing on the basis of low price and decision makers whose firms are competing on the basis of product differentiation is significantly different from 0.

HO9: The mean relative weight placed upon the external market opportunity factor by decision makers with a Ph.D. degree is not significantly different than the mean relative weight placed upon the external market opportunity factor by decision makers without a Ph.D. degree.

Discussion: This hypothesis is intended to test for a significant, actual difference in importance placed upon the R&D Area selection factor of external market opportunity between decision makers who possess Ph.D. degrees and decision makers who do not possess Ph.D. degrees.

Results: Table 16 summarizes the data analyzed in evaluating this hypothesis.

Table 16. Comparison of the Mean Relative Weight for Opportunity Assigned by Decision Makers Who Possess A Ph.D. Degree and the Mean Relative Weight for Opportunity Assigned by Decision Makers Who Do Not

Variable	*Sample Population (n)*	*Mean*	*t-value**	*Pr>t (1-tail)*
RW-Opportunity	Ph.D. (21)	53.3	0.53	0.30
RW-Opportunity	Non-Ph.D. (32)	57.4		

* n = 53

Interpretation: Sufficient evidence did not exist to reject the null hypothesis. Thus, the average difference in the importance placed upon the external market opportunity factor in the selection of R&D Areas for investment between decision makers possessing their Ph.D. degrees and decision makers not possessing their Ph.D. degrees is not shown to be significantly different from zero.

HO10: The mean relative weight placed upon the internal technological fit factor by decision makers with a Ph.D. degree does not differ significantly from the mean relative weight placed upon the internal technological fit factor by decision makers without a Ph.D. degree.

Discussion: This hypothesis is intended to test for a significant, actual difference in importance placed upon the R&D Area selection factor of internal technological fit between decision makers who possess their Ph.D. degrees and decision makers who do not possess their Ph.D. degrees.

Results: Table 17 summarizes the data analyzed in evaluating this hypothesis.

Table 17. Comparison of the Mean Relative Weight for Relatedness Assigned by Decision Makers Who Possess A Ph.D. Degree and the Mean Relative Weight for Relatedness Assigned by Decision Makers Who Do Not

Variable	*Sample Population (n)*	*Mean*	*t-value**	*Pr>t (1-tail)*
RW-Relatedness	Ph.D. (21)	46.7	-0.53	0.30
RW-Relatedness	Non-Ph.D. (32)	42.6		

* n = 53

Interpretation: Sufficient evidence did not exist to reject the null hypothesis. Thus, the average difference in the importance placed upon the internal technological fit factor in the selection of R&D Areas for investment between decision makers possessing their Ph.D. degrees and decision makers not possessing their Ph.D. degrees is not shown to be significantly different from zero.

HO11: The business economic performance indicators are correlated with the subjective weight that decision makers place on the external market opportunity factor.

Discussion: If the business economic performance of the firm is indeed influenced by technology, then the selection of the appropriate R&D Area impacts the economic performance of the firm. Selection of R&D Areas is a strategic choice that has been hypothesized to be best made when consideration is given to the external market opportunity factor.

Results: Table 18 summarizes the data analyzed in evaluating this hypothesis.

Table 18. Correlation of Business Economic Performance Indicators and the Subjective Weight Decision Makers Place On External Market Opportunity Pearson Correlation Coefficients/Probability>|R| Under Ho: Rho=0

Variable	*Sales Growth*	*Net Income Growth*	*Return On Investment*
SW-Opportunity - r	0.12	0.11	0.07
- p*	0.39	0.45	0.61

* n = 53

Interpretation: The business economic performance indicators of sales growth, net income growth, and return on investment were not significantly correlated with the stated importance that decision makers place upon the external market opportunity factor in the selection of R&D Areas for investment.

HO12: The business economic performance indicators are correlated with the subjective weight that decision makers place on the internal technological fit factor.

Discussion: If the business economic performance of the firm is indeed influenced by technology, then the selection of the appropriate R&D Area impacts the economic performance of the firm. Selection of R&D Areas is a strategic choice that has been hypothesized to be best made when consideration is given to the internal technological fit factor.

Results: Table 19 summarizes the data analyzed in evaluating this hypothesis.

Table 19: Correlation of Business Economic Performance Indicators and the Subjective Weight Decision Makers Place On Internal Technological Fit - Pearson Correlation Coefficients/Probability>|R| Under Ho: Rho=0

Variable	*Sales Growth*	*Net Income Growth*	*Return On Investment*
SW-Relatedness - r	-0.12	-0.11	-0.07
- p*	0.39	0.45	0.61

* n = 53

Interpretation: The business economic performance indicators of sales growth, net income growth, and return on investment were not significantly correlated with the stated importance that decision makers place upon the internal technological fit factor in the selection of R&D Areas for investment.

HO13: The business economic performance indicators are significantly correlated with the relative weight that decision makers place on the external market opportunity factor.

Discussion: If the business economic performance of the firm is indeed influenced by technology, then the selection of the appropriate R&D Area impacts the economic performance of the firm. Selection of R&D Areas is a strategic choice that has been hypothesized to be best made when consideration is given to the external market opportunity factor.

Results: Table 20 summarizes the data analyzed in evaluating this hypothesis.

Table 20. Correlation of Business Economic Performance Indicators and the Relative Weight Decision Makers Place On External Market Opportunity - Pearson Correlation Coefficients/Probability>|R| Under Ho: Rho=0

Variable	*Sales Growth*	*Net Income Growth*	*Return On Investment*
RW-Opportunity - r	0.06	0.09	0.01
- p*	0.66	0.53	0.96

* n = 53

Interpretation: The business economic performance indicators of sales growth, net income growth, and return on investment are not significantly correlated with the actual importance that decision makers place upon the external market opportunity factor in the selection of R&D Areas for investment.

HO14: The business economic performance indicators are significantly correlated with the relative weight that decision makers place on the internal technological fit factor.

Discussion: If the business economic performance of the firm is indeed influenced by technology, then the selection of the appropriate R&D Area impacts the economic performance of the firm. Selection of R&D Areas is a strategic choice that has been hypothesized to be best made when consideration is given to the internal technological fit factor.

Results: Table 21 summarizes the data analyzed in evaluating this hypothesis.

Table 21. Correlation of Business Economic Performance Indicators and the Relative Weight Decision Makers Place On Internal Technological Fit - Pearson Correlation Coefficients/Probability>|R| Under Ho: Rho=0

Variable	*Sales Growth*	*Net Income Growth*	*Return On Investment*
RW-Relatedness - r	-0.12	-0.10	-0.07
- p*	0.39	0.45	0.61

* n = 53

Interpretation: The business economic performance indicators of sales growth, net income growth, and return on investment were not significantly correlated with the actual importance that decision makers place upon the internal technological fit factor in the selection of R&D Areas for investment.

HO15: The insight of decision makers into the importance of the external market opportunity factor is significantly, positively correlated with the business economic performance indicators.

Discussion: The knowledge of the importance of external market opportunities to the selection of R&D Areas for investment is reflected by the difference in the decision makers' stated importance of the factor and the actual importance given the factor in the decision-making exercise. An ability to consistently select R&D Areas for investment is reflected by a high level of understanding of the importance of the factor (i.e., stated importance approximates the actual importance). Thus, a high level of consistency (i.e., a small difference between the stated importance of external market opportunity and the actual importance placed upon external market opportunity) is expected of high performing firms.

Results: Table 22 summarizes the data analyzed in evaluating this hypothesis.

Table 22. Correlation of Business Economic Performance Indicators and the Insight Decision Makers Possess Of The Importance Of The External Market Opportunity Factor - Pearson Correlation Coefficients/Probability>|R| Under Ho: Rho=0

Variable	*Sales Growth*	*Net Income Growth*	*Return On Investment*
Opportunity Insight - r	0.19	0.13	0.23
- p*	0.17	0.36	0.10

* n = 53

Interpretation: The correlation between the business economic performance indicators and the decision maker's insight into the importance of the external market opportunity factor is not statistically significant with respect to the population of data analyzed. However, the correlation between insight of the external market opportunity factor and return on investment is borderline significant (0.10).

HO16: The insight of decision makers into the importance of the internal technological fit factor is significantly, positively correlated with the business economic performance indicators.

Discussion: The knowledge of the importance of internal technological fit to the selection of R&D Areas for investment is reflected by the difference in the decision makers' stated importance of the factor and the actual importance given the factor in the decision-making exercise. An ability to consistently select R&D Areas for investment is reflected by a high level of understanding of the importance of the factor (i.e., stated importance approximates the actual importance). Thus, a high level of consistency (i.e., a small difference between the stated importance of internal technological fit and the actual importance placed upon internal technological fit) is expected of high performing firms.

Results: Table 23 summarizes the data analyzed in evaluating this hypothesis.

Table 23. Correlation of Business Economic Performance Indicators and the Insight Decision Makers Possess of the Importance of the Internal Technological Fit Factor - Pearson Correlation Coefficients/Probability>|R| Under Ho: Rho=0

Variable	*Sales Growth*	*Net Income Growth*	*Return On Investment*
Relatedness Insight - r	0.19	0.13	0.23
- p*	0.17	0.36	0.09

* n = 53

Interpretation: The correlation between sales growth and net income growth and the decision maker's insight into the importance of the internal technological fit factor is not statistically significant with respect to the population of data analyzed. However, the correlation between return on investment and the decision-makers' insight of the internal technological fit factor is borderline significant (0.09).

Regression of Factors Against Economic Performance

A regression was performed in which the following variables were regressed against the three measures of the decision-makers' firm's economic performance: SW-Opportunity, SW-Relatedness, RW-Opportunity, RW-Relatedness, Ph.D., and Competitive Basis. The resulting beta weights are given in Tables 24-26.

Table 24. Parameter Estimates of Variables Regressed Against ROI

Variable	*Parameter Estimate*	*t-value*	*Pr>t*
SW-Opportunity	0.01	0.78	0.44
SW-Relatedness	-0.01	-0.78	0.44
RW-Opportunity	-0.01	-0.51	0.61
RW-Relatedness	0.01	0.51	0.61
Ph.D.	0.28	0.96	0.34
Competitive Basis	-0.04	-0.14	0.89

n=53, R^2=0.03, F=0.36, Pr>F=0.83

Table 25. Parameter Estimates of Variables Regressed Against Net Sales Growth

Variable	*Parameter Estimate*	*t-value*	*Pr>t*
SW-Opportunity	0.01	0.75	0.45
SW-Relatedness	-0.01	-0.75	0.45
RW-Opportunity	-0.01	-0.33	0.74
RW-Relatedness	0.01	0.33	0.74
Ph.D.	0.61	2.05	0.05
Competitive Basis	-0.34	1.09	0.28

n=53, R^2=0.13, F=1.78, Pr>F=0.15

Table 26. Parameter Estimates of Variables Regressed Against Net Income Growth

Variable	*Parameter Estimate*	*t-value*	*Pr>t*
SW-Opportunity	0.01	0.48	0.63
SW-Relatedness	-0.01	-0.48	0.63
RW-Opportunity	0.01	0.12	0.91
RW-Relatedness	-0.01	-0.12	0.91
Ph.D.	0.26	0.97	0.34
Competitive Basis	-0.08	-0.28	0.78

n=53, R^2=0.03, F-value=0.38, Pr>F=0.82

Note that the SWs and the RWs are simply the negative values of the respective SW and/or RW for the other R&D Area selection factor. This is due to the dependency of one value upon the other. For example, if the SW of opportunity is 40%, then the SW of internal technological fit must be 1 - 40%, or 60%.

The variable with consistently the largest parameter estimate was whether or not the decision maker possessed a Ph.D. degree. The parameter estimates for this variable ranged from 0.258 to 0.615 across the three economic performance measures. The next largest parameter estimate was the firm's primary basis for competing when it was regressed against net sales growth (i.e., 0.34).

The preceding parameter estimates and the R^2 values associated with the models when the variables were regressed against the economic performance measures (i.e., 0.03, 0.03, and 0.13) indicate that either (1) a more important factor not measured nor controlled by this study (e.g., ability of a firm to transition from research to development) outweighs the importance of selecting R&D Areas, or, (2) There is only a weak relationship between selection of R&D Areas and resulting economic performance.

CHAPTER VI. CONCLUSIONS

The results obtained in testing the 16 hypotheses within this research provide a high-level view of the decision-making process in which areas are selected for R&D investment. In particular, this research has documented the effect of several factors (i.e., basis for competing, whether or not the decision maker possesses a Ph.D. degree, emphasis placed upon internal technological fit, and emphasis placed upon external market opportunity) on that decision-making process. A summary of these general findings is shown in Table 27.

In general, the data have not shown that the emphasis which decision makers place upon the two research area selection factors proposed by Maidique and Patch (1988) is significantly related to economic performance. If the authors cited in Chapter II are to be believed, all of whom indicated that technology makes a vital contribution to the success of firms in a competitive market, then one might arrive at one of the following conclusions:

- The methodology utilized in this study is flawed.
- Even when testing within an industry, unknown factors which were neither controlled nor measured in this study can mask the effects of technology on the economic performance of a firm. (This conclusion would indicate that the relationship between R&D Area selection and economic performance is dependent upon controlling additional factors other than those attributable to industry effects.)
- The theory proposed by Maidique and Patch is not applicable to the specific industry studied by this research (i.e., the pharmaceutical preparation industry).

These possible conclusions are discussed further in the following paragraphs.

Table 27. Summary Of Research Findings

Factor of Interest	*General Trend*
Competitive Basis of the Firm	Firms classified as emphasizing low price as their competitive basis, on the average, place more emphasis upon the internal technological fit factor when selecting R&D Areas for investment.
Emphasis Placed Upon Internal Technology Fit	The emphasis placed upon internal technological fit does not seem to be correlated strongly with any of the three economic performance indicators.
Emphasis Placed Upon External Market Opportunity	The emphasis placed upon external market opportunity does not seem to be correlated strongly with any of the three economic performance indicators.

With regard to the possibility of a flawed methodology, each segment of the methodology used within this study has been successfully used to perform past research. However, there does exist the possibility that the specific data collection instrument was in some way faulty. A faulty data collection instrument is deemed unlikely due to (1) the excellent results obtained during pilot testing, (2) the high within rater consistency values obtained, and (3) the fact that the instrument was modelled after instruments previously used to collect similar data for decision modelling analyses. However, each of these three could falsely support the instrument as valid if the decision makers' attempted to fit their ratings of the research areas to correspond with their stated importance of the two factors.

The possibility that certain variables might mask the correlation between decision criteria weights and economic performance was recognized a priori and, therefore, the data for this study was collected from a single industry in an attempt to control many competitive variables. Although sampling was performed within an industry where performance is known to be related to R&D decisions, the manner in which research areas are selected may not account for a significant variance in the economic performance of firms. For example, the possibility of a large difference in the ability of firms to develop the results of research into marketable products is a valid concern. Stating this concern another way, regardless of a firm's ability to select research areas, a firm must be able to develop the research findings if business economic performance indicators are to be impacted.

With regard to the third possible conclusion (i.e., whether or not the theory proposed by Maidique and Patch is valid within the pharmaceutical preparation industry), two possibilities exist. The first possibility is that the theory applies but was not considered by earlier decision makers in the industry. In other words, perhaps the R&D Areas selected in earlier years which are impacting business economic performance today, were chosen without considering these criteria. Thus, the current economic performance indicators do not correspond to the data collected via the decision making exercise. Secondly, the theory simply may not apply to the pharmaceutical industry. In other words, the theory may only apply to industries possessing certain characteristics.

Other subsections of this chapter discuss the conclusions from the tests of grouped data. Note that the demographics of the responses received were adequate to test all hypotheses listed in Chapter III. Specifically, 39.6% (21) of the responders possessed a Ph.D. degree while 60.4% (32) did not possess a Ph.D. degree. Also, 13.2% (7) of the responders' firms were determined to emphasize price as a basis for competing, 67.9% (36) of the responders' firms were determined to emphasize product differentiation as a basis for competing, and 18.9% (10) of the responders' firms did not group with either strategy and were, therefore, assumed to be following neither strategy explicitly (i.e., "stuck in the middle").

All Data

When all data was analyzed, a high level of internal consistency was found (i.e., within rater R^2=0.93). This value shows that decision makers, on the average, applied a fairly stable level of importance to each factor as they listed the attractiveness of the nine R&D Areas in the decision-making exercise. In addition, the mean relative weights of the two factors and the corresponding subjective weights of the two factors were not significantly different. This represents a high level of understanding of each factor's importance to the research area selection process, at least as was measured in the data collection instrument.

On the average, decision makers in the pharmaceutical preparation industry both stated and actually placed more importance upon the R&D Area selection factor of external market opportunity. However, when data from the entire population were analyzed, the only statistic near significant (borderline at 0.10) was that the stated importance of external market opportunity was significantly different from the stated importance of internal technological fit. Some possible reasons for no findings of significance among the entire data population follow:

1. The pharmaceutical preparation industry consists of firms which compete on the basis of low price and firms which compete on the basis of product differentiation. This fundamental difference in the competitive strategies of firms within the industry may have resulted in large standard deviations in the evaluations of the attractiveness of R&D Areas. This might indicate that Maidique and Patch's theory needs further segmentation along some condition (e.g., competitive basis) before it is applicable.
2. The two factors, external market opportunity and internal technological fit, need further segmentation into sub-elements before effects can be observed. For example, perhaps the external market opportunity criterion is comprised of multiple variables, such as number of competitors in the market and the expected sales revenue of the market, which may mask the effects of each other.
3. The criteria proposed by Maidique and Patch are not factors of importance when selecting R&D Areas for investment.
4. The theory proposed by Maidique and Patch may not be applicable to the pharmaceutical preparation industry for some yet to be discovered reason.
5. The methodology utilized may not be applicable to this strategic decision.

Competitive Basis

When the data are segmented into the two basic categories of competitive strategy emphasized (i.e., product differentiation and low price), statistically significant differences were discovered between firms which utilize product differentiation and firms which utilize low price. In particular, the stated importance of the two R&D Area selection factors and the actual importance placed upon the two R&D Area selection factors were, on the average, different for the two groups. On the average, external market opportunity was shown to be the more important factor to decision makers whose firms emphasize product differentiation as their basis for competing. Thus, firms that utilize product differences as a basis for competing are believed to strive to deliver a product to the market that generates a demand by providing something desired (i.e., external market opportunity). Similarly, decision makers whose firms emphasize low price as their basis for competing stated and actually placed, on the average, more importance on the R&D Area selection factor of internal technological fit. Specifically, these data support the belief that firms that utilize low price as a competitive basis will strive for efficiency of operations and will, therefore, seek R&D Areas that will permit dual use of existing resources.

Thus, this research has shown that the selection of research areas is influenced by the primary competitive basis employed by the decision-maker's firm. Recall that this was expected because all strategic decisions are supposed to be made in support of the firm's primary basis for competing (Porter, 1985).

Ph.D. vs. Non-Ph.D.

Contrary to what was expected based upon the work of Eiduson (1962), who stated that researchers perceive research risk differently from non-researchers, no statistically significant differences were discovered between decision makers who possess Ph.D. degrees and decision makers who do not possess Ph.D. degrees. Recall that this result was unexpected because it was believed that possession of a Ph.D. degree is highly correlated with an understanding of the research process and it was believed that an understanding of the research process would facilitate the R&D Area selection process. The fact that no statistically significant difference was observed in this area may be related to any combination of the following.

1. The non-Ph.D. decision makers may have obtained, via work experience, a level of understanding of the research process comparable to that of a person possessing a Ph.D. degree.
2. Since the data collection instrument was submitted to executives and not persons currently involved in research, whether or not the decision maker possessed a Ph.D. degree may be outweighed by the decision-maker's current focus on the business aspects of the decision.
3. An understanding of the research process does not assist the decision maker in the selection of research areas for investment.

The first possible reason listed for no findings of significance between decision makers who possess a Ph.D. degree and decision makers who do not possess a Ph.D degree appears logical. The majority of executives completing the questionnaires were VPs of R&D. Hence, the degree of familiarity with the research process is expected to be extremely high among all decision makers, whether or not the decision maker possesses a Ph.D. degree, due to the content of their job responsibilities. In fact, many of the decision makers may have worked in the R&D organization prior to being promoted to VPs of R&D.

The second possible reason for not obtaining any significant findings with respect to whether or not a decision maker possesses a Ph.D degree relates to the possibility that the executive decision makers may have been in a managerial position for an extended period of time. Thus, because they currently primarily concerned with non-research, business-related decisions, they may have changed their decision making traits. Perhaps their current list of responsibilities have resulted in a new approach to decision making.

The third possible reason for no findings of significance with respect to whether or not the decision maker possesses a Ph.D. degree is also possible, although thought to be unlikely. This option suggests that a person's knowledge of the research process does not impact the selection of research areas in which to invest. Knowledge of decision areas has been shown to be highly correlated with an ability to make other strategic decisions.

Decision-Makers' Insight

Contrary to what was expected based upon the works of Ansoff (1984), Schilit and Paine (1988), Stahl (1989) and Porter (1985), the amount of insight the decision makers possessed of the importance of the two key decision criteria was not significantly correlated with the economic performance of their firms. This finding suggests that either opportunity and relatedness are not the key decision criteria when a firm in the pharmaceutical industry is selecting research areas for investment, or, some additional consideration, perhaps the ability of firms to develop research findings and/or the ability of firms to implement the products of the development process.

If the first possible explanation is to be accepted, then this study has in fact provided evidence that opportunity and relatedness are not the decision criteria of importance when firms in the pharmaceutical industry select areas for research investment. This possibility leads to two questions, namely:

(1) What are the important decision criteria when a firm in the pharmaceutical industry selects research areas for investment? and

(2) If opportunity and relatedness are the important considerations when firms in other industries select research areas for investment, what characteristics of the pharmaceutical preparation industry cause other decision criteria to be more important.

Correlations With Economic Performance

No statistically significant correlation was discovered between the three business economic performance indicators (i.e., net income growth, sales growth, and return on investment) and either the stated importance of the two R&D Area selection factors or the actual importance placed upon the two R&D Area selection factors. Furthermore, no significant correlation was observed between the amount of insight that the decision maker possessed of the importance of the two R&D Area selection factors and either net income growth or sales growth. (The correlation between insight and return on investment was borderline significant at 0.10)

The possible reasons why the data did not exhibit significant correlations with economic performance are the same as those provided in the earlier discussion of why no significant findings were found for the entire industry (i.e., all data).

Applicability to Practitioners

In Chapter I, it is stated that this research would be of interest to both academicians and practitioners. The primary benefit to academicians is the expansion of an area fertile for research. The potential benefits to academicians are stated in more detail in Chapter VII "Implications For Future Research".

In general, the results of this research may be used by practitioners to increase their awareness of two key factors to consider when selecting research areas for investment, namely internal technological fit and external market opportunity. It has been shown that decision makers whose firms emphasize low price as a competitive strategy tend to emphasize internal technological fit when selecting research areas for investment. Alternatively, decision makers whose firms utilize product differences as a competitive basis tend to emphasize external market opportunity when selecting research areas for investment. Thus, it is believed that decision makers should attempt to select research areas in a manner which is most supportive of their firm's primary competitive strategy.

In addition, a weak correlation has been shown between the importance placed upon the internal technological fit criterion and the firm's return on investment. Thus, if a practitioner's firm desires to have a high return on investment, then the practitioner should place more importance upon the internal technological fit factor than they place upon the external market opportunity factor when selecting R&D Areas for investment. Thus, it is believed that decision makers should attempt to select research areas in a manner which is most supportive of their firm's economic performance goals, especially if the economic performance goals are measured in terms of return on investment.

However, practitioners should use caution when attempting to draw conclusions from this dissertation because:

- No causal relationship has been shown.
- Due to the low correlation with business economic performance indicators, it is believed that all factors important to the research area selection process have not been accounted for. These other factors might include turbulence of the industry's primary technology area, number of competitors in the industry, projected change

in industry sales, etc.

- The applicability of this research to other industries is unknown.

CHAPTER VII. IMPLICATIONS FOR FUTURE RESEARCH

The results of the research documented by this dissertation lead to yet other research questions surrounding the relationships between technology decisions and strategic management. These new types of questions can generally be placed into one of the following general categories: expansion of the scope of this research (i.e., test for consistency between industries); identification of key determinants of external market opportunity and internal technological fit (i.e., determine the elements which deem an external market opportunity and internal technological fit as either good or bad); and examination of other strategic management of technology decisions.

These potential research areas are discussed in more detail within subsections of this chapter.

Expansion of Scope

The limited generalizability of this research (i.e., applicable only to pharmaceutical industry) can be verified by performing similar research with data obtained from decision makers in a different industry. If the results of the research on data collected from a second industry are consistent with the results obtained in this study of the pharmaceutical industry, evidence will be provided which suggests that there is no industry effect.

However, if the results of the research on data from a second industry yield different results from the pharmaceutical industry, further studies may be warranted to assess the impact of the five industry forces upon the selection of R&D Areas for investment. For example, if differences between industries are discovered, expanding the scope to compare the decision-making practices between industries will lead to the identification of individual variables responsible for those differences. This may begin by studying correlation coefficients of key variables between industries with similar results.

Analysis of Decisions from Firms Grouped as Stuck-In-The-Middle

One of the most intriguing extensions of this research involves further analyses of the 10 firms classified as following neither a low price strategy nor a product differentiation strategy. Of interest with regard to these 10 firms would be a comparison of their economic performance to that of firms classified as emphasizing low price and to that of firms classified as emphasizing product differentiation. Note that Porter (1985) asserted that firms which fail to adopt either a low price or product differentiation strategy are "stuck-in-the-middle" and their resulting performance because of their failure to commit to either strategy should be worse.

Another interesting analysis involving the group of firms classified as stuck-in-the-middle would be a comparison of the mean weights for each factor to both, the mean weights of the group of firms which emphasize low price and the group of firms which emphasize product differentiation. The thought here would be that these firm should exhibit less consistency (i.e., make strategic decisions in a more haphazard manner). This may also be thought of as simply a new comparison of the mean difference of the insight of each group into the importance of the decision criteria.

Identifying Key Elements of Factors

After verifying the importance of external market opportunity and internal technological fit to the R&D Area selection process, the next logical question is "What sub-elements determine the degree of external market opportunity and the internal technological fit R&D Areas possess?" In other words, is there a group of variables that are strongly correlated with high external market opportunity (e.g., age of primary industry, number of competitors, sales volume, etc.) and high internal technological fit (e.g., turbulence of key technology, education level of staff, degree of match with existing products, degree of match with anticipated products, etc) which can be assessed ?

Furthermore, while the internal consistency of this questionnaire was high, the comparison of values across decision makers might include some extraneous noise associated with the individual characteristics of the decision maker. It is believed that identification and utilization of elements that comprise the internal technological fit and the external market opportunity might produce more significant results via a reduction in noise and interpretation errors.

Because the ability of individual firms to control the external market opportunity is low, identification of elements which are either determinants or predictors of the degree of external market opportunity is desirable. Knowledge of these elements may provide firms with additional time within which to respond to opportunities, or, may provide increased control of their own destiny by controlling sub-elements that influence the external market opportunity.

If the key sub-elements can be identified, an attempt could then be made to quantify the optimum magnitude of the investment for R&D Areas. This type of study is a precursor to optimization of the research area selection process.

Other Technology-Related Decisions

Since the strategic decision-making practices of the research area selection process of the pharmaceutical preparation industry were efficiently modelled, the methodology utilized in this research (i.e., decision modelling) has once again been shown to be a useful tool in analyzing the strategic decision-making habits of executives. The advantages of this methodology (i.e., internal consistency is measurable, ethical considerations, and statistical validity) serve to enhance its power as a research tool.

Because the interrelationships between technology decisions and strategic management are many, this same tool should be used to study other technology-related decisions, such as the degree of collaboration with competitors, selection of competitors for collaboration, influence of social and political factors on technology policy making, and the desired trade-off between mobility and internal technological fit.

BIBLIOGRAPHY

Allison, G. A., *Essence of Decision: Explaining the Cuban Missile Crisis*, Little Brown, Boston, MA, 1971.

Andrews, K. R., *The Concept of Corporate Strategy, Revised Edition*, Irwin, Homewood, IL, 1980 (First Published 1971).

Ansoff, H. I., *Implanting Strategic Management*, Prentice-Hall International, Englewood Cliffs, NJ, 1984.

Antonides, G., and van der Sar, N. L., "Individual Expectations, Risk Perception and Preferences in Relation to Investment Decision Making," *Journal of Economic Psychology*, Vol. 11, Issue 2, pp. 227-245, June 1990.

Baker, N. R., "R&D Project Selection Models: An Assessment," *IEEE Transactions on Engineering Management*, Vol. 21, pp. 165-171, 1974.

Balakrishnan, S., and Wernerfelt, B., "Technical Change, Competition and Vertical Integration," *Strategic Management Journal*, Vol. 7, No. 4, pp. 347-359, July-August 1986

Barwise, P., Marsh, P., Thomas, K., and Wensley, R., "Research on Strategic Investment Decisions," *Strategic Management Research: A European Perspective*, McGee, J., and Thomas, H., Editors, John Wiley, New York, NY, pp. 23-52, 1987.

Boeker, W., "Strategic Change: The Effects of Founding and History," *Academy of Management Journal*, Vol. 32, No. 3, pp. 489-515, 1989.

Boeker, W., "The Development and Institutionalization of Subunit Power in Organizations," *Administrative Science Quarterly*, Vol. 34, No. 3, pp. 388-410, 1989.

Bower, J. L., *Managing the Resource Allocation Process*, Harvard University Press, Cambridge, MA, 1970.

Burgelman, R. A., and Maidique, M. A., *Strategic Management of Technology and Innovation*, Irwin, Homewood, IL, 1988.

Burgelman, R. A., Kosnik, T. J., and van den Poel, M., "Toward An Innovative Capabilities Audit Framework," *Strategic Management of Technology and Innovation*, Burgelman, R. A., and Maidique, M. A., Editors, Irwin, Homewood, IL, pp. 31-44, 1988.

Burns, T., and Stalker, G. M., *The Management of Innovation*, Tavistock Publications, London, England, 1961.

Butler, R., Davies, L., Pike, R., and Sharp, J., "Strategic Investment Decision-Making: Complexities, Politics and Processes," *Journal of Management Studies*, Vol. 28, Issue 4, pp. 395-415, July 1991.

Bylinski, G., "America's Hot Young Scientists," *FORTUNE*, Vol. 122, No. 9, pp. 56-69, October 8, 1990.

Cetron, M. J., Martino, J., and Roepcke, L., "The Selection of R and D Program Content - Survey of Quantitative Methods," *IEEE Transactions on Engineering Management*, Vol. 14, pp. 4-13, 1967.

Chaganti, R., and Sambharya, R., "Strategic Orientation and Characteristics of Upper Management," *Strategic Management Journal*, Vol. 8, No. 4, pp. 393-401, July-August 1987.

Clark, K. B., "What Strategy Can Do For Technology," *Harvard Business Review*, No. 6, pp. 93-98, November-December 1989.

Connolly, T., *Scientists, Engineers, and Organizations*, Brooks-Cole Engineering Division, Monterey, CA, 1983.

Dess, G. G., and Davis, P. S., "Porter's (1980) Generic Strategies as Determinants of Strategic Group Membership", *Academy of Management Journal*, Vol. 27, No. 3, pp. 467-488, 1984.

Deal, T. E., and Kennedy, A. A., *Corporate Culture: The Rites and Rituals of Corporate Life*, Addison-Wesley, Reading, MA, 1982.

Drucker, P. F., *Managing In Turbulent Times*, Harper and Row, New York, NY, 1980.

Duncan, R. B., "Multiple Decision-Making Structures In Adapting To Environmental Uncertainty: The Impact on Organization Effectiveness," *Human Relations*, Vol. 26, pp. 273-291, 1973.

Dutton, J. E., and Duncan, R. B., "The Creation of Momentum for Change Through the Process of Strategic Issue Diagnosis," *Strategic Management Journal*, Vol. 8, No. 3, pp. 279-295, May-June 1987.

Eiduson, B. T., *Scientists: Their Psychological World*, Basic Books, New York, NY, 1962.

Foster, R. N., *Innovation: The Attacker's Advantage*, Simon & Schuster, New York, NY, 1986.

Frederickson, J. W., and Mitchell, T. R., "Strategic Decision-Processes: Comprehensiveness and Performance In An Industry With An Unstable Environment," *Academy of Management Journal*, Vol. 27, pp. 399-423, June 1984.

Fusfeld, H. I., and Langlois, R. N., Editors, *Understanding R&D Productivity*, Pergamon Press, New York, NY, 1982.

Goodman, P. S., and Pennings, J., Editors, "Perspectives and Issues: An Introduction," *New Perspectives On Organizational Effectiveness*, Jossey-Bass, San Francisco, CA, pp. 1-12, 1977.

Green, P. E., and Krieger, A. M., "Product Design Strategies for Target-Market Positioning," *Journal of Product Innovation Management*, Vol. 8, Issue 3, pp. 189 - 202, September 1991.

Hambrick, D. C., "Environment, Strategy and Power In Top Management Teams," *Administrative Science Quarterly*, Vol. 26, pp. 253-276, 1981.

Hambrick, D. C., "Environmental Scanning and Organizational Strategy," *Strategic Management Journal*, Vol. 3, pp. 159-174, April-June 1982.

Hardy, C., and Pettigrew, A. M., "The Use of Power in Managerial Strategies for Change," *Research on Technological Innovation, Management and Policy, Volume 2*, Rosenbloom, R. S., Editor, JAI Press, Greenwich, CT, pp. 11-45, 1985.

Hayes, R. H., and Wheelwright, S. C., *Restoring Our Competitive Advantage*, John Wiley, New York, NY, 1984.

Hegarty, W. H., and Hoffman, R. C., "Who Influences Strategic Decisions?" *Long Range Planning*, Vol. 20, No. 2, pp. 76-85, April 1987.

Hofer, C. W., and Schendel, D. E., *Strategy Formulation: Analytical Concepts*, West Publishing, St. Paul, MN, 1978.

Horwitch, M., *Technology in the Modern Corporation: A Strategic Perspective*, Pergamon Press, New York, NY, 1989.

Horwitch, M., and Sakakibara, Y., "The Changing Strategy-Technology Relationship in Technology-Based Industries: A Comparison of the United States and Japan," *Research on Technological Innovation, Management and Policy, Volume 3*, Rosenbloom, R. S., Editor, JAI Press, Greenwich, CT, 1981.

Jelinek, M., and Goldhar, J. D., "The Interface Between Strategy and Manufacturing Technology," *Columbia Journal of World Business*, Vol. 18, No. 1, pp. 26-36, Spring 1983.

Kanter, R. M., *The Change Masters: Innovation for Productivity in the American Corporation*, Simon & Schuster, New York, NY, 1983.

Kanter, R. M., "Supporting Innovation and Venture Development in Established Companies," *Journal of Business Venturing*, No. 1, pp. 47-60, 1985.

Kantrow, A. M., Editor, *Survival Strategies For American Industry*, John Wiley, New York, NY, 1983.

King, L., "F.Y.I.," *Industrial Engineering*, Vol. 22, No. 9, p. 96, September 1990.

Lieberman, M. B., and Montgomery, D. B., "First-Mover Advantages," *Strategic Management Journal*, Vol. 9, pp. 41-58, 1988.

Link, A. N., and Tassey, G., *Strategies For Technology-based Competition*, Lexington Books, Lexington, MA, 1987.

Loveridge, R., and Pitt, M., Editors, *The Strategic Management of Technological Innovation*, John Wiley, New York, NY, 1990.

Maidique, M. A., and Patch, P., "Corporate Strategy and Technological Policy," *Readings in the Management of Innovation, Second Edition*, Tushman, M. L., and Moore, W. L., Editors, Ballinger, Cambridge, MA, pp. 236-248, 1988.

March, J. G., and Olsen, J. P., *Ambiguity and Choice in Organizations*, Universities for Laget, Oslo, Norway, 1976.

Maslow, A. H., *The Psychology of Science*, Harper and Row, New York, NY, 1966.

McCormack, R., "How Corporate R&D Laboratories are Coping With the Times," *New Technology Week*, Vol. 3, No. 39, King Communications, p. 2, Washington, DC, October 2, 1989.

Mendelsohn, E., Roe, A., Saunders, R. C., Siepert, A. F., Kaplan, N., and Shepard, H. A., *The Management of Scientists*, Beacon Press, Boston, MA, 1963.

Miles, R. E., and Snow, C. C., *Organizational Strategy, Structure, and Process*, McGraw-Hill, New York, NY, 1978.

Mintzberg, H., "Patterns in Strategy Formation," *Management Science*, Vol. 24, No. 9, pp. 934-948, 1978.

Mintzberg, H., Waters, J., Pettigrew, A. M., and Butler, R., "Studying Deciding: An Exchange of Views Between Mintzberg and Waters, Pettigrew, and Butler," *Organization Studies*, Vol. 11, Issue 1, pp. 1-16, 1990.

Morone, J., "Strategic Use of Technology," *California Management Review*, Vol. 31, No. 4, pp. 91-110, Summer 1989.

Mumford, E., and Pettigrew, A. M., *Implementing Strategic Decision*, Longman, White Plains, NY, 1975.

O'Connell, J., and Zimmerman, J., "Scanning the International Environment," *California Management Review*, Vol. 22, No. 2, pp. 15-23, Winter 1979.

Pake, G. E., "From Research to Innovation at Xerox," *Research on Technological Innovation, Management and Policy, Volume 3*, Rosenbloom, R. S., Editor, JAI Press, Greenwich, CT, pp. 1-32, 1981.

Pearce, J. A., and Robinson, R. B., "A Measure of CEO Social Power in Strategic Decision-Making," *Strategic Management Journal*, Vol. 8, No. 3, pp. 297-304, May-June 1987.

Pearce, J. A., and Robinson, R. B., *Strategic Management: Strategy Formulation and Implementation, 3rd Edition*, Irwin, Homewood, IL, 1988.

Pelz, D. C., "Problem Solvers vs. Decision Makers," *Managing Advancing Technology*, Vol. 2, 1972.

Pelz, D. C., and Andrews, F. M., *Scientists In Organizations: Productive Climates For Research and Development, Revised Edition*, University of Michigan Press, Ann Arbor, MI, 1966.

Perrino, A. C., and Tipping, J. W., "Global Management of Technology," *Research-Technology Management*, Vol. 33, Issue 3, Industrial Research Institute, New York, NY, pp. 12-19, May-June 1989.

Perrow, C., "The Short and Glorious History of Organizational Theory," *Classics of Organization Theory*, pp. 313-323, 1973.

Perrow, C., "Three Types of Effectiveness Studies," *New Perspectives On Organizational Effectiveness*, Goodman, P. S., and Pennings, J., Editors, Jossey-Bass, San Francisco, CA, pp. 96-105, 1977.

Pettigrew, A. M., *The Policies of Organizational Decision-Making*, Tavistock Publications, London, England, 1973.

Pettigrew, A. M., "Towards a Political Theory of Organizational Intervention," *Human Relations*, Vol. 28, No. 3, pp. 191-208, 1975.

Pettigrew, A. M., "The Politics of Organizational Change," *The Human Side of Information Processing*, Niels Bjorn Anderson, Editor, North-Holland, 1980.

Pettigrew, A. M., *Context and Politics in Organizational Change*, Prentice Hall and Oxford, London, England, 1984.

Pfeffer, J., *Power in Organizations*, Pitman, London, England, 1981.

Pfeffer, J., and Salancik, G., "Organizational Decision-Making as a Political Process," *Administrative Science Quarterly*, Vol. 19, pp. 135-151, 1974.

Porter, M., "How Competitive Forces Shape Strategy," *Harvard Business Review*, Vol. 57, No. 2, pp. 137-145, March-April, 1979.

Porter, M., *Competitive Strategy: Techniques For Analysing Industries and Competitors*, The Free Press, New York, NY, 1980.

Porter, M., *Competitive Advantage: Creating and Sustaining Superior Performance*, The Free Press, New York, NY, 1985.

Porterfield, R. I., and Stahl, M. J., "Joint Venture Decisions", Presentation at the Academy of Management Meeting, Chicago, IL, 1986.

Quinn, J. B., *Strategies for Change: Logical Incrementalism*, Irwin, Homewood, IL, 1980.

Quinn, J. B., "Managing Strategies Incrementally," *Omega*, Vol. 10, No. 6, pp. 613-627, 1982.

Ramanujam, V., and Venkatraman, N., "Planning Systems Characteristics and Planning Effectiveness," *Strategic Management Journal*, Vol. 8, No. 5, pp. 453-468, September-October 1987.

Roberts, E. B., *The Dynamics of Research and Development*, Harper & Row, New York, NY, 1964.

Schendel, D. E., and Hofer, C. W., *Strategic Management: A New View Of Business Policy and Planning*, Little Brown, Boston, MA, 1979.

Schilit, W. K., and Paine, F. T., "An Empirical Examination of the Strategic Decision-Making Process," Working Paper, 1988.

Shrivastava, P., "Rigor and Practical Usefulness of Research in Strategic Management," *Strategic Management Journal*, Vol. 8, No. 1, pp. 77-92, January-February 1987.

Shrivastava, P., and Nachman, S. A., "Strategic Leadership Patterns," *Strategic Management Journal*, Vol. 10, pp. 51-66, Summer 1989.

Simon, H. A., *The Sciences of the Artificial*, MIT Press, Cambridge, MA, 1969.

Slovic, P., and Lichtenstein, S., "Comparison of Bayesian and Regression Approaches to the Study of Information Processing in Judgement," *Organizational Behavior and Human Performance*, Vol. 6, pp. 649-744, 1971.

Slovic, P., Fischoff, B., and Lichtenstein, S., "Behavioral Decision Theory," *Annual Review of Psychology*, Vol. 28, pp. 1-36, 1977.

Souder, W. E., "Comparative Analysis of R&D Investment Models," *AIEE Transactions*, Vol. 4, pp. 57-64, 1972.

Souder, W. E., "A System For Using R&D Project Evaluation Methods," *Research Management*, Vol. 21, pp. 29-37, 1978.

Stahl, M. J., *Strategic Executive Decisions: An Analysis of the Difference Between Theory and Practice*, Quorum Books, New York, NY, 1989.

Stahl, M. J., and Zimmerer, T. W., "Modeling Strategic Acquisition Decisions", *Academy of Management Journal*, Vol. 27, pp. 369-383, 1984.

Steele, L. W., *Managing Technology: The Strategic View*, McGraw-Hill, New York, NY, 1989.

Tushman, M. L., and Moore, W. L., Editors, *Readings In The Management of Innovation, Second Edition*, Ballinger, New York, NY, 1988.

Value Line Investment Survey, Part 1 Summary & Index, Vol. XLVII, No. 6, Value Line Publishing, New York, NY, October 25, 1991.

Venkatraman, N., and Grant, H., "Construct Measurement in Organizational Strategy Research: A Critique and Proposal," *Academy of Management Review*, Vol. 11, No. 1, pp. 71-87, 1986.

Venkatraman, N., and Ramanujam, V., "Measurement of Business Economic Performance: An Examination of Method Convergence," *Journal of Management*, Vol. 13, No. 1, pp. 109-122, Spring 1987.

Weick, K. E., "Re-Punctuating the Problem," *New Perspectives On Organizational Effectiveness*, Paul Goodman and Johannes Pennings, Editors, Jossey-Bass, San Francisco, CA, pp. 193-225, 1977.

Wheelwright, S. C., *Manufacturing Issues 1985*, Booz-Allen & Hamilton, 1985.

Willard, G. E., and Cooper, A. C., "Survivors of Industry Shake-Outs: The Case of the U. S. Color Television Set Industry," *Strategic Management Journal*, Vol. 6, No. 4, pp. 299-318, October-December 1985.

APPENDICES

APPENDIX A
DATA COLLECTION INSTRUMENT

University of Tennessee
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May 11, 1992

Distribution (See Appendix B)

Collection of Data for Research

We are presently collecting data for the purpose of analyzing strategic decisions within the pharmaceutical preparation industry. Specifically, we are examining the selection of research areas in the pharmaceutical preparation industry.

This research requires that we collect data from decision makers involved in the process of selecting research areas for investment. Note that we have obtained your firm's name from a list of pharmaceutical preparation firms identified as being involved in research and development. Therefore, we ask that you complete the following questionnaire (or forward it to a person with more influence over the research areas selected) and return it to me in the enclosed envelope by June 1, 1992.

A pilot test of the questionnaire revealed that it should require approximately 15 minutes to complete.

Upon request, all persons submitting data used in the analysis will be provided with a summary page of the results. Should you have any questions, please feel free to contact me via mail to the above address or via telephone to (615) 974-5061.

Very truly yours,

Dr. Michael J. Stahl, Associate Dean for Research and External Affairs
University of Tennessee
College of Business Administration

SELECTING RESEARCH AREAS FOR INVESTMENT

Instructions

This form should be completed by an individual who has input to his/her organization's selection of research areas for funding.

Part I. Research Selection Decision-Making Exercise

All R&D areas have been stated to possess two attributes which should be used to determine their attractiveness for investment, namely external market opportunity and internal technological fit. Please rank your assessment of the relative importance of these two factors by allocating 100 points to the two factors (i.e., the sum the points assigned to the two factors should equal 100). The factor you believe to be more important to the selection of R&D Areas should be assigned proportionally more points.

1. External market opportunity importance: _____ (The external market opportunity factor is intended to represent the potential to enhance the attractiveness of products to customers in the market.)
2. Internal technological fit importance: _____ (The internal technological fit factor is intended to represent an assessment of the match between an R&D Area and a firm's current or anticipated products. Thus, internal technological fit can be considered as a measure of the R&D Area's match to an organization's existing resources and capabilities.)

Please assess your business's performance with respect to your major competitors on the basis of the following by circling the number most closely resembling your assessment for each indicator.

3. Sales growth

   worse than competitors -2 ... -1 ... 0 ... 1 ... 2 better than competitors
   same as

4. Net income growth

   worse than competitors -2 ... -1 ... 0 ... 1 ... 2 better than competitors
   same as

5. Return on investment

   worse than competitors -2 ... -1 ... 0 ... 1 ... 2 better than competitors
   same as

Please assess the importance of the following competitive variables to your firms strategy for competing in the marketplace. A score of 1 to 5 should be assigned to each competitive variable where a 1 represents not important at all and a 5 represents extremely important.

__new product development	__customer service	__operating efficiency
__product quality control	__trained personnel	__high inventory levels
__competitive pricing	__broad product range	__refine existing products
__brand identification	__marketing innovation	__distribution control
__raw material procurement	__low outside financing	__serving specific markets
__specialty products	__compete in high price market segments	
__advertising	__reputation within industry	
__forecasted market growth	__manufacturing process innovation	

Please indicate how strongly you would recommend providing funds for each of the following nine research areas based upon their stated internal technological fit and external market opportunity characteristics.

Specifically, indicate the degree to which you would support funding the described R&D areas by circling the number (on the accompanying Likert-scale) that corresponds to your degree of recommendation. (Note that "0" indicates a strong recommendation not to fund R&D in the area, "10" indicates a strong recommendation to fund R&D in the area, and "5" indicates no strong feelings toward funding or not funding.)

Example

A. External market opportunity (High)
B. Internal technological fit (High)

Strongly Recommend Not Funding	0	1	2	3	4	5	6	7	8	9	10	Strongly Recommend Funding

R&D Area 1 Considerations

A. External market opportunity (High)
B. Internal technological fit (High)

Strongly Recommend Not Funding	0	1	2	3	4	5	6	7	8	9	10	Strongly Recommend Funding

R&D Area 2 Considerations

A. External market opportunity (High)
B. Internal technological fit (Medium)

Strongly Recommend Not Funding	0	1	2	3	4	5	6	7	8	9	10	Strongly Recommend Funding

R&D Area 3 Considerations

A. External market opportunity (High)
B. Internal technological fit (Low)

Strongly Recommend Not Funding	0	1	2	3	4	5	6	7	8	9	10	Strongly Recommend Funding

R&D Area 4 Considerations

A. External market opportunity (Medium)
B. Internal technological fit (High)

Strongly Recommend Not Funding	0	1	2	3	4	5	6	7	8	9	10	Strongly Recommend Funding

R&D Area 5 Considerations

A. External market opportunity (Medium)
B. Internal technological fit (Medium)

Strongly Recommend Not Funding	0	1	2	3	4	5	6	7	8	9	10	Strongly Recommend Funding

R&D Area 6 Considerations

A. External market opportunity (Medium)
B. Internal technological fit (Low)

Strongly Recommend Not Funding	0	1	2	3	4	5	6	7	8	9	10	Strongly Recommend Funding

R&D Area 7 Considerations

A. External market opportunity (Low)
B. Internal technological fit (High)

Strongly Recommend Not Funding	0	1	2	3	4	5	6	7	8	9	10	Strongly Recommend Funding

R&D Area 8 Considerations

A. External market opportunity (Low)
B. Internal technological fit (Medium)

Strongly Recommend Not Funding	0	1	2	3	4	5	6	7	8	9	10	Strongly Recommend Funding

R&D Area 9 Considerations

A. External market opportunity (Low)
B. Internal technological fit (Low)

Strongly Recommend Not Funding	0	1	2	3	4	5	6	7	8	9	10	Strongly Recommend Funding

Part II. Background Information

Please answer the following questions on the basis of your current organization.

1. Please check the following degrees you possess and identify the field of study in which each degree was received. (Please identify any degree possessed but not listed in the other category.)

	Field of Study (e.g., engineering)
_____ Bachelor's	______________________
_____ M.A.	______________________
_____ M.S.	______________________
_____ M.B.A.	______________________
_____ Ph.D.	______________________
_____ Other	______________________

2. Check whichever of the following is more important to your organization as a means of attracting customers:

   ___ a lower price than your competitors offer on comparable products

   ___ a favorably differentiated product (i.e., special product features)

3. How many years have you been in your present position? ____________________

APPENDIX B
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