FUNCTIONAL STRATEGIC OBJECTIVES OVER PRODUCT AND PROCESS LIFE CYCLES

by

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(ABSTRACT)

This thesis is an initial attempt at analyzing the "product-process matrix," a framework suggesting the interaction of product and process life cycles. The objectives of this thesis were to test the theory surrounding the "product-process matrix" and also test theories concerning the transition of strategic objectives between "product-process matrix" regions. The methodology included conducting a survey of Virginia manufacturing firms on strategic concerns, constructing a database into which survey responses were loaded, and analyzing survey responses.

Results of this survey suggested that the theory surrounding the "product-process matrix" may be inappropriate. Results also indicated the possibility that row and column descriptions of the current "product-process

matrix" may need alterations in order to be more applicable to manufacturing firms. Further research is necessary to examine possible biases associated with the survey instrument and survey sample. After such research has been undertaken, it is recommended that continued work in this area may help to improve understanding the interaction between markets and manufacturing processes.

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Chapter 1

INTRODUCTION

1.1 Preface

In 1979, Drs. Robert H. Hayes and Steven C. Wheelwright proposed a framework representing the relationship between the market and manufacturing process. This framework, entitled the "product-process matrix," incorporated the marketing concept of the product life cycle and a newly devised concept, called the process life cycle. By using their "product-process matrix," Hayes and Wheelwright argued that companies need to coordinate their manufacturing processes and markets. Specifically, they contended that the diagonal of the matrix would be the region where the product structure would be properly paired with the "natural" process structure. Companies moving away from the diagonal would differentiate themselves from their competitors. Although moving away from the diagonal would not necessarily be improper, the farther the company moved away from the diagonal region, the more it would become necessary for it to develop a market and/or process niche.

The novelty of the "product-process matrix" was that it served as the first attempt to model the selection of a manufacturing process technology in accordance with market conditions and vice-versa, the selection of an appropriate market in accordance with a company's current manufacturing technology. The model has since been referenced in literature to describe manufacturing technology selection. The matrix, however, is not limited to just process technology selection. Hayes and Wheelwright [1979a, 1979b, 1984] have taken the matrix and expanded its applicability to the area of manufacturing strategy formulation. Using their "product-process matrix," they have discussed the topics of strategic priorities, key management tasks, and distinctive competence of operations. They have shown that emphasis placed on particular priorities, tasks, and modes of distinctive competence alters over the course of both the product life cycle and process life cycle.

Although Hayes and Wheelwright [1979a, 1979b, 1984] effectively discussed the applicability of the "product-process matrix," there are criticisms regarding this applicability. One criticism is that Hayes and Wheelwright present little empirical evidence to defend their matrix concept. Minimal case examples are used to illustrate the matrix, and those cases that are selected are generally located around the diagonal region. Another criticism is that the strategic concerns identified by the matrix as

changing are not supported through empirical study. Rather, they are presented from a theoretical standpoint.

Empirical research is needed to address these criticisms. Such a research endeavor needs to assimilate numerous case data, group these data by "product-process matrix" regions, and determine the prevalent strategic characteristics within these regions. Among such strategic characteristics, a particular strategic characteristic of interest is the objectives that drive facility activities, a strategic concern also presented by Hayes and Wheelwright [1984]. An additional step for this research endeavor would be to assess the differences in strategic characteristics between "product-process matrix" regions. Since each region represents a point within the product life cycle and process life cycle, an assessment of these strategic characteristics (objectives) would be a surrogate to an assessment of characteristics over product and process life cycles. By identifying this research need, a mission is established for research. With a manufacturing facility often identified as the "functional level," this thesis is appropriately titled "Functional Strategic Objectives Over Product and Process Life Cycles."

1.2 Definitions

Before outlining this research, definitions are provided in this section for terms that are used throughout this thesis. These definitions serve to clarify terms which may have varied meanings. Specific attention should be paid to the terms "product life cycle" and "process life cycle."

Process Life Cycle -- a concept suggested by Hayes and Wheelwright [1979a, 1979b, 1984], which represents the evolution of the technology of the production process. Evolution begins (theoretically) with a process characterized by high flexibility and low cost-effectiveness. Process technology evolves to an eventual state of low flexibility and high degrees of mechanization, standardization, and capital-intensity.

Product Life Cycle -- a marketing concept representing the evolution of sales over the course of a successful product's life. Evolution of a product's sales begins with a slow growth rate followed by an exponential growth rate if the product becomes accepted within the market. Eventually, sales growth will decrease as market potential shrinks. Ultimately, sales will decline as consumers substitute newer products for the current product.

The "Product-Process Matrix" -- a model developed by Hayes and Wheelwright [1979a, 1979b, 1984] illustrating the interaction of the product life cycle and the process life cycle. Using four stages to represent each life cycle, a sixteen-region matrix is constructed. The stages associated with the product life cycle are stage one, low volume, low standardization, one-of-a-kind products; stage two, low volume, multiple variety products; stage three, high volume, few major variety products; and stage four, high volume, standardized, commodity products. The stages associated with the process life cycle are stage one, jumbled flow (job shop) manufacturing; stage two, disconnected flow (batch) manufacturing; stage three, connected flow (assembly line) manufacturing; and stage four, continuous manufacturing.

Strategy -- a plan of action to be undertaken by a company. Hayes and Wheelwright [1984] suggest three levels of strategy: corporate strategy, business strategy, and functional strategy. Corporate strategy is the highest level and is where the company definition and direction are determined. The business strategy is one which guides the activities of the business unit(s). The functional strategy is a compilation of activities that direct individual operations. These activities pertain to such areas as accounting, finance, manufacturing, marketing, and research and development.

Functional Strategic Objectives -- the priorities (objectives) identified by management for functional level areas. Examples may include manufacturing, which might prioritize flexibility, cost reduction, and/or quality; marketing, which might prioritize profit generation, market share growth, and/or market share maintenance; and research and development, which might prioritize product development, product improvement, process development, and/or process improvement. This research concentrates only on priorities at a functional level. In addition, priorities will be limited to the three functions of manufacturing, marketing, and research and development.

1.3 Statement of Purpose

The "product-process matrix" is a theoretical construct for analyzing the relationship between the life cycles of product and process. It has been used to address strategic concerns over the course of the product and process life cycles. These strategic concerns, however, have not been specific to particular regions within the matrix, but rather, to the diagonal region of the matrix. This shows a need to establish which regions are feasible and to determine what strategic concerns are associated with particular matrix regions. Undertaking such an effort would provide an improved understanding of functional strategy

over the life cycles of product and process. As previously mentioned, the strategic concerns under investigation were the strategic objectives relating to the functions of marketing, manufacturing, and research and development.

Research using the "product-process matrix" provides insight into the make-up of appropriate strategic objectives over the course of both life cycles. Using these objectives, an enhanced framework can be constructed with the intention of illustrating how market and process influence strategic objectives. At present, no research involving and/or enhancing the "product-process matrix" has been identified. This points to the uniqueness of this research and warrants the undertaking of this research effort.

1.4 Organization of Thesis

This thesis is divided into six chapters. The first chapter serves to introduce and define the topic to be discussed. The second chapter reviews literature on the product life cycle, process life cycle, the "product-process matrix," strategy, and strategy formulation across life cycles. The third chapter presents the objectives, scope, and assumptions of this research. The fourth chapter presents the procedures for achieving these aforementioned objectives and describes the materials that were used. The

fifth chapter provides the results of this research and is followed by the sixth chapter, which presents conclusions derived from these results, summarizes the research endeavor, and makes recommendations for further research.

Chapter 2

LITERATURE REVIEW

2.1 Introduction

Before the objectives and methodology are presented, a foundation is next established for the research area to be investigated. This includes a review of the literature on the product life cycle concept, process life cycle concept, "product-process matrix," strategy, and strategy over product and process life cycles.

2.2 Product Life Cycle

2.2.1 The Product Life Cycle Concept

The product life cycle is a relatively new concept based on the literature of Dean [Dean, 1950]. It is the premise of the product life cycle concept that the sales function for an individual product or group of products undergoes an evolutionary process. This evolutionary process is often represented by a curvilinear function

through the plotting of total revenue or unit sales over time. Once this curve has been identified for a product category, it is suggested by product life cycle literature [Rink and Swan, 1979; Wasson, 1974] that this curve can be representative for later and/or similar products.

The most popular and discussed product life cycle curve is the traditional one, described by Rink and Swan [1979] as a bell-shaped curve. The more accepted description of the traditional product life cycle curve [Luck, 1973; Wasson, 1974] is an S-curve with an eventual downward slope [see Figure 2.1]. Other curves are also discussed in product life cycle literature. These include the cycle-recycle, growth-decline-plateau, stable maturity, and fad curves [Rink and Swan, 1979; Wasson, 1974] [see Figure 2.2].

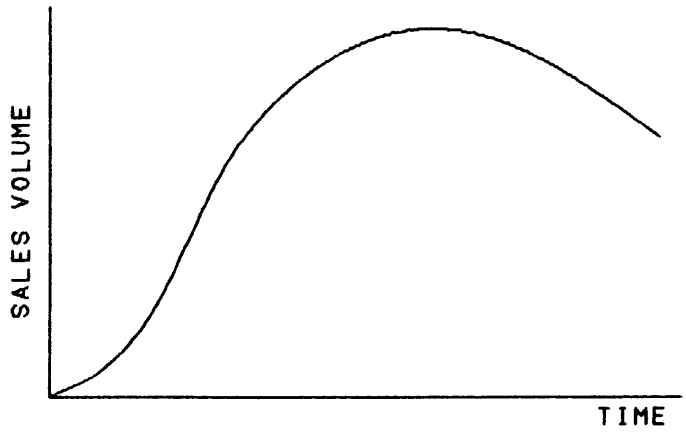


Figure 2.1: The Traditional Product Life Cycle

Even with such curves documented, the product life cycle concept is criticized with respect to its validity. Critics, such as Dhalla and Yuspeh [1976], contend that the concept is not empirically valid nor useful. Proponents, such as Rink and Swan [1979], believe the opposite to be true. This disagreement has led to an ongoing controversy within marketing literature concerning the product life cycle concept. Since the "product-process matrix" incorporates the product life cycle concept and also since this research will address the product life cycle concept, an examination of arguments from both sides is necessary.

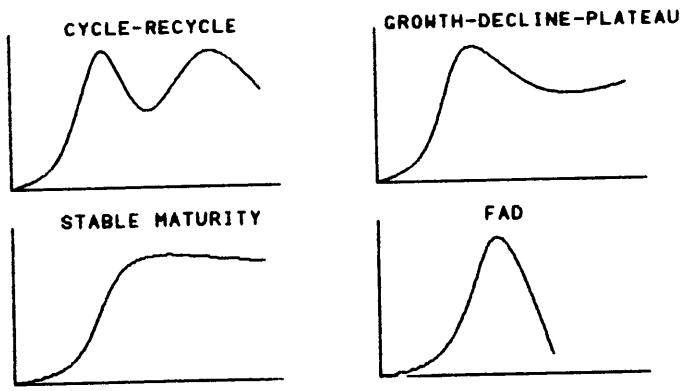


Figure 2.2: Other Product Life Cycle Curves

2.2.2 Criticism of the Product Life Cycle Concept

One major criticism of the product life cycle concept is its representation of sales as an independent function

[Dhalla and Yuspeh, 1976; Day, 1981]. The true sales function may not be so easily described since sales data are actually related to factors associated with the company, the market, and the economy. Another criticism is that defining a product's life cycle may not be easily achieved [Dhalla and Yuspeh, 1976; Day, 1981]. The product life cycle is often associated with only one market, which is not always the case. Sometimes a product will develop new markets, which will boost sales and dramatically alter the product life cycle curve, even though previous sales may have reflected a different product life cycle curve. Hayes and Wheelwright [1984] present the example of the color television, which was in a stable, relatively horizontal point in its product life cycle prior to the personal computer revolution, but now has a growing product life cycle as a result of the computer industry requiring color televisions for use as computer monitors. A product may also have a different product life cycle when market segments are differentiated. Hayes and Wheelwright [1984] use the example of oscilloscopes. As a group, oscilloscopes reflect a particular product life cycle curve. When a group of oscilloscopes is split into different price and feature segments, a variety of product life cycles can be generated.

Dhalla and Yuspeh [1976] also assert that the product life cycle concept is often expressed in vague, qualitative terms with little empirical foundation. This, they contend,

has misled many companies to terminate prematurely products which would have otherwise continued to return revenue and market opportunities for the individual companies.

Countering product life cycle criticism, proponents of the product life cycle concept state that the concept provides a substantial framework for representing a product's development [Rink and Swan, 1979; Hayes and Wheelwright, 1984]. Rink and Swan believe that the concept's organization of a product's development through the identification of particular stages promotes the product life cycle concept as a viable tool for managerial policy determination. Hayes and Wheelwright [1984, page 203] support the concept, for it...

> "provides a framework for thinking about a product's evolution through time and the kind of market segments that are likely to develop at various points in time. It also highlights the need to change the priorities that govern manufacturing behavior as products and markets evolve."

Empirical studies have also been performed to validate the product life cycle concept. Rink and Swan [1979] reviewed nineteen different empirical studies, finding evidence for the traditional product life cycle. These studies also found evidence supporting the existence of cycle-recycle, increasing sales, decreasing sales, and stable maturity patterns. Rink and Swan concluded from

these studies that product life cycles do exist for various products with the weight of this evidence showing the traditional product life cycle to be the most common curve. Harrell and Taylor [1981] developed and tested a product life cycle model to evaluate forecast accuracy. Their results suggested that product life cycles could be identified and used for forecasting sales.

Although these arguments neither prove nor disprove the concept of a product life cycle, this research incorporated this concept, since it is a framework that outlines market development for a product category. This decision is also based on another factor. The product life cycle concept incorporated into the "product-process matrix" is a variant of the standard product life-cycle concept. This variation is considered to be an improvement towards distinguishing market composition along a product category's evolution. Instead of basing sales evolution upon volume, the "product-process matrix" uses product and market characteristics to identify transitions. This allows for a better distinction of evolution or, as stated within the context of the product life cycle concept, a better distinction of product life cycle stages. A discussion of these stages follows.

2.2.3 Product Life Cycle Stages

To assist in describing the evolutionary aspect of product sales, marketing has attached particular stages to the product life cycle concept [Rink and Swan, 1979]. These stages not only represent a change in sales, but a transition in the behavior and composition of the market. In the case of the traditional product life cycle, four to six stages following entrance to the market have been suggested [ibid]. The four-stage product life cycle is the more commonly referenced model in marketing literature with the four stages being introduction, growth, maturity, and decline [ibid]. Figure 2.3 below shows the four-stage product life cycle.

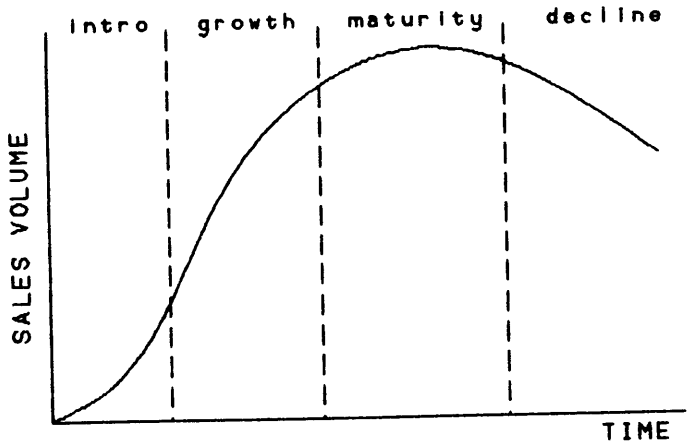


Figure 2.3: Product Life Cycle Stages

When the product first enters the market, it starts in the introduction stage. This is generally considered the beginning of a product's commercial life. The introduction stage is characterized by slowly developing sales caused by mixed reactions in the marketplace. Initially, consumer recognition of the product is minimal. As the product remains in the market and as consumer recognition increases, sales begin a gradual upward trend in sales.

If sales begin to increase at a rapid, even exponential rate, the product enters the growth stage. In this stage, consumer acceptance becomes intensified, causing a dramatic increase in market demand for the product. Eventually, sales increases will slow and reduce as the market approaches its saturation point.

Upon market saturation, the product enters the maturity stage. Sales level off and result in lower profit margins. Consumer acceptance is no longer important to product success. Instead, consumer loyalty becomes the key aspect.

As consumers begin to substitute new products for the current product, sales begin a continued downward trend signifying the decline stage. Profitability and cost-effectiveness of the product decrease. The issue of when to terminate the product becomes important.

Although it serves as a device for explaining the evolution of sales, the concept of traditional product life cycle stages has several limitations for this research. One

limitation is that each stage does not provide an explicit description of market behavior and composition. Rather, it is implied that a particular set of market and product characteristics will occur. A second limitation is that these stages are only representative of the traditional product life cycle. As noted by product life cycle research, there are additional product life cycle curve possibilities. This points to the need for an alternative to the traditional product life cycle stage construct. This research presents the stages suggested by the "product-process matrix" as such an alternative.

2.2.4 Product Life Cycle Stages of the "Product-Process" Matrix

Hayes and Wheelwright [1979a, 1979b, 1984] offer a slightly different perspective of the product life cycle, which is incorporated into their "product-process matrix." Although they do agree with an evolution of four stages, they do not base the product life cycle strictly on sales volume. Instead, their product life cycle addresses aspects of product line diversity, product standardization, and sales volume. Their four stages are given as follows:

Stage One	low volume, low standardization, one-of-a-kind product
Stage Two	multiple variety product having low volume
Stage Three	few major variety product of higher volume
Stage Four	high volume, high standardization, commodity product

Between the stages of the traditional product life cycle and the stages defined by Hayes and Wheelwright, the latter are better descriptors of the market for comparing manufacturing and marketing functions. The stages of introduction, growth, maturity, and decline of the traditional approach are vague in providing insight into the important characteristics at different stages within the product life cycle. Hayes and Wheelwright's stages are more explicit in their description of market (and product) characteristics. In addition, these stages can be representative of varying market scenarios, which allows the modeling of different product life cycle curves. As a result of these advantages, the stages associated with the "product-process matrix" are preferred and therefore are utilized in this research.

2.3 Process Life Cycle

2.3.1 The Process Life Cycle Concept

Like the product life cycle, the process life cycle is a relatively new concept (Abernathy and Townsend 1975) suggesting that manufacturing characteristics of a product (product category) undergo an evolutionary process. These characteristics include aspects related to manufacturing cost, flexibility, quality, and technology. Abernathy and Townsend [1975] contend that the manufacturing process will initially begin as a "fluid process" and move towards a "systematic process." They state that the initial "fluid process" is characterized by highly flexible, general-purpose equipment and labor. Operations have an ill-defined capacity with production being one-at-a-time. The ultimate "systematic process" is a highly mechanized, standardized, and automated environment. Both equipment and labor is highly specialized. Operations have a predetermined capacity with production at a continuous level in order to achieve economies of scale.

2.3.2 Characteristics of the Process Life Cycle

According to Hayes and Wheelwright [1984], the dominant characteristics of the process life cycle are throughput volumes, process innovation, and automation/vertical

integration. These characteristics are at a low degree in the initial stages, but increase as the process moves towards the "systematic" side of the continuum. In the final stage, throughput volume and automation/vertical integration are at peak levels. Process innovation is at a reduced level, having already peaked during the transition period between the initial "fluid" process and eventual "systematic" process.

Another aspect suggested by Hayes and Wheelwright [1984], which characterizes the process life cycle, is manufacturing cost. In the beginning stages, the low volume and high degree of variety for a particular product category forces numerous set-ups and inconsistencies in production flow. This limits the impact of learning and keeps costs high. In later stages, dedication of equipment and labor allows organizational learning to take place due to higher volumes and a lower degree of variety within the product category. This results in lower manufacturing costs. In the final stage, manufacturing cost may or may not increase since learning curve improvements may or may not provide significant cost reductions. If learning does not take place, manufacturing cost becomes dependent upon economies of scale.

2.3.3 Process Life Cycle Stages

The process life cycle, like the product life cycle, uses designated stages to define the evolutionary process. Abernathy and Townsend [1975] presented a model consisting of the three stages of early, middle, and mature processes. For each stage, the six categories of materials, technology, labor, scale, product, and modes of process change were addressed.

Hayes and Wheelwright [1979a, 1979b, 1984] extended the three-stage process life cycle of Abernathy and Townsend to a four-stage process life cycle. This four-stage process life cycle concentrated on process flow as the distinguishing characteristic for stage transition. The four stages were identified as jumbled flow, disconnected flow, connected flow, and continuous flow. Since these four stages represent the process life cycle in the "product-process matrix," this research uses these process life cycle stages, which are presented by Hayes and Wheelwright. A description of these stages follows.

The first stage, jumbled flow, is representative of a job shop. This stage is characterized by high degrees of flexibility with both equipment and the labor force. Capacity, production flow, and processing standards are ill-defined due to high variations in product design within the product category. Production remains in-house.

The second stage is disconnected flow. This stage is representative of a batch flow process, where products begin to follow a standard flow pattern within production. This is due to a reduction in the variation of product design. Flexibility begins to reduce as equipment and labor become dedicated to specific tasks, although dedication is still minimal. With production flow becoming slightly standardized, production capacity and total production times may be roughly estimated.

The third stage, connected flow, is characterized by assembly line production. At this level, equipment and labor become dedicated to particular tasks as product design variation reduces even further. These tasks, which are not always in-house, are synchronized to produce a finished product. As a result of this specialization, overall production flexibility becomes limited in terms of the ability to offer a wide variety of products. Capacity is clearly defined in terms of number of items produced per unit time.

The fourth stage is continuous flow, which is the most specialized of the four stages. Production is dedicated to a primary product using highly mechanized, standardized, and automated techniques. Labor is highly specialized and dedicated to particular tasks, commonly serving in process monitoring. As a result of total specialization, there is no flexibility in the product mix. Capacity is again

clearly defined, but now in terms of physical quantities instead of number of items produced per unit time.

2.3.4 Criticism of Process Life Cycle Stages

The process life cycle concept, as the product life cycle concept, is not without criticism. Hayes and Wheelwright [1984] themselves state that the concept's assumption of sequential stages may not be applicable to all cases of process. The cost and flexibility of a particular manufacturing process may limit a firm's ability to move to another processing stage at will. Another criticism also provided by Hayes and Wheelwright [1984] is that the assumption of a four-stage transition may not represent all transition cases of process technology. They present the example of flexible manufacturing centers (FMC's), which are hard to place within the context of the matrix since they are capital intensive, but of high flexibility. Based on the descriptions of process life cycle stages, FMC's would be appropriately positioned between the disconnected flow process and connected flow process. However, based on their high flexibility, FMC's would have to be categorized separately from standard batch and assembly line processes, which the process life cycle does not address.

A third criticism, offered in this proposal, is that the process life cycle concept assumes that all processes

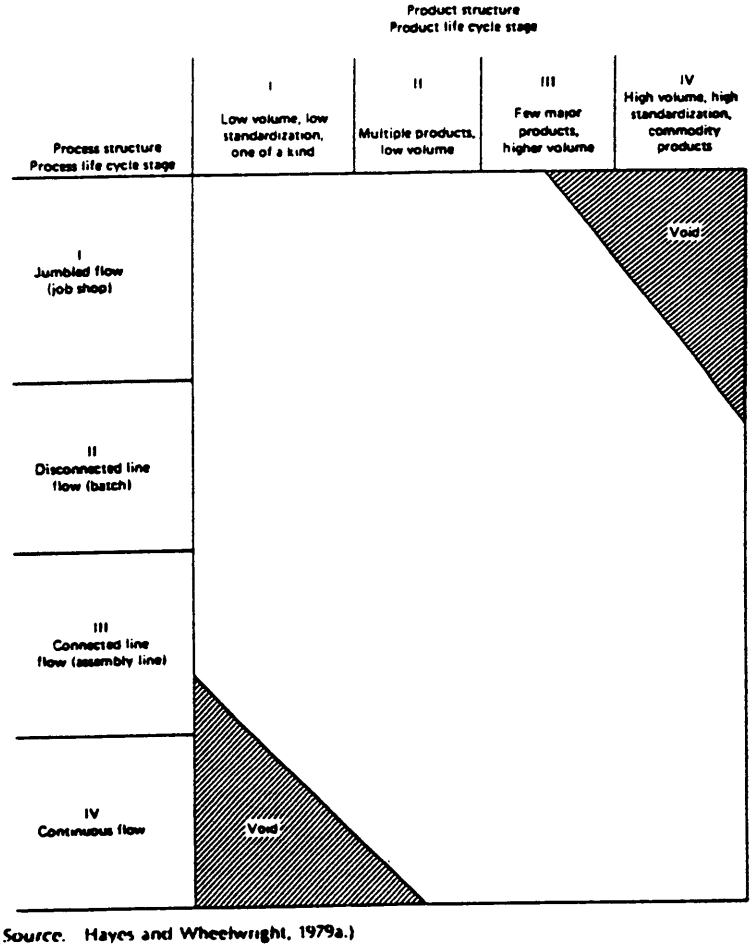
undergo an evolution. This evolution begins with a job shop process and ends with a continuous process. For various products, the manufacturing process will not change since there may be an inability to produce the product with any other manufacturing process. Examples such as beer, various chemicals, detergent, steel, and wine production are not normally (and perhaps would never be) produced with a job shop or assembly line. Locomotives are not likely to be produced in a continuous process. Instead, these products are usually produced in batches (or one-at-a-time), thus only a disconnected flow (or jumbled flow) process is appropriate.

Although such criticisms limit the applicability of the process life cycle concept, the concept may be applicable to various manufacturing processes. Assuming the concept is applicable to these processes, the process life cycle is incorporated and tested within this research. Hayes and Wheelwright [1984] also support the use of the concept for it outlines the capabilities and key tasks that must be addressed at each stage of the process life cycle. With key tasks including strategic objectives, which is a focus of this research, the process life cycle concept will serve as a useful tool and therefore, is used in this research.

2.4 The Interaction of Product and Process Life Cycles

2.4.1 The "Product-Process Matrix"

The "product-process" matrix presents a framework for understanding the interrelationship of manufacturing and marketing. The rows of the matrix represent the stages of the process life cycle. The columns represent the stages of the product life cycle. [See Figure 2.4]

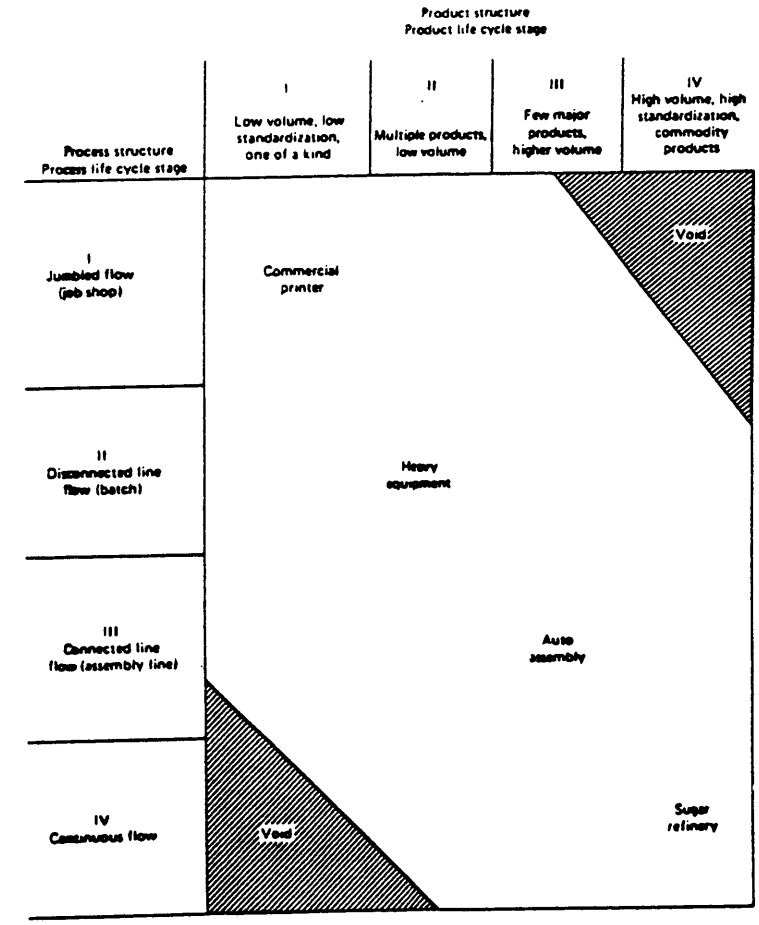


(Source. Hayes and Wheelwright, 1979a.)

Figure 2.4: The "Product-Process Matrix"

The premise behind the "product-process matrix" is that both manufacturing process and market characteristics of the product category should evolve together in order that they are appropriately matched. Hayes and Wheelwright [1979a, 1979b, 1984], who proposed the "product-process matrix," believe that, in the initial stages of the product life cycle, a firm should utilize project, job shop, or batch flow processes in order to satisfy a low volume, high variety market. As the product life cycle enters later stages, the process should change to an assembly line or continuous process in order to meet the demands of a high volume, low variety market. This suggests that appropriate matches follow the diagonal of the matrix. Hayes and Wheelwright [1979a, 1979b, 1984] present examples using the industries of commercial printing, heavy equipment, automobiles, and sugar to illustrate this. They contend that the norm of the commercial printing industry will use a jumbled flow process to meet a diverse market. The norm of the heavy equipment industry will use a disconnected flow process to meet a low volume, mixed variety market. The norm of the auto industry will turn to a connected flow process to satisfy a market with few major, high volume varieties. And the norm of the sugar industry will utilize a continuous flow process to satisfy a market of high standardization and volume. Figure 2.5 illustrates these

examples within the framework of the "product-process matrix".



(Source: Hayes and Wheelwright, 1979a.)

Figure 2.5: Positioning of Firms Within The "Product-Process Matrix"

Although the standard of industries may reside along the diagonal of the "product-process matrix," Hayes and Wheelwright do not suggest that firms from individual industries may be located at different points within the matrix. Instead, they suggest that firms off the diagonal are exceptions to the rule. Hayes and Wheelwright [1979a,

1979b, 1984] stated that these exceptions within the matrix structure are a result of a market niche. They show the example of Rolls-Royce versus the standard automaker, where Rolls-Royce, which uses a job-shop process, has been able to remain competitive against automakers, which use an assembly line process. Rolls-Royce, they explain, has established within the entire car market a secure, low volume market niche, which centers on elegant, expensive cars of a perceived high status. This has allowed Rolls-Royce to utilize a job-shop (jumbled flow) process since volume is low and the product is customized. The norm of the auto industry engages in a larger volume, more price-sensitive market. To maintain a competitive position, the standard automaker must use an assembly line process to meet this market.

A fault with this assertion by Hayes and Wheelwright is that comparing Rolls-Royce to the entire auto industry is not practical. It is believed that an individual firm cannot be compared to an entire industry since industries are a multitude of varying types of firms within varying markets. A more appropriate comparison is comparing individual car companies (e.g. Rolls-Royce to BMW and to Ford). In this way, one is not comparing "one apple" to "the crate," but instead, an "apple" to another "apple." A rationale for comparing on a firm-to-firm basis is that when individual firms are analyzed, a transition between regions

may be observed. A particular example is the electronics industry. As an industry, little or no transition can be observed. However, from a firm standpoint, it could have been observed that Texas Instruments in the 1970's changed its manufacturing to better fit its product category market [Hayes and Wheelwright, 1979a, 1979b]. Although process region switching is infrequent, it is assumed that it does occur. It is hypothesized that switching between market regions has a higher occurrence rate.

2.4.2 Strategic Concerns Addressed By The "Product-Process Matrix"

It is inferred by Hayes and Wheelwright [1979a, 1979b, 1984] within their discussion of matrix positioning that the strategic objectives of Rolls-Royce, which is located above the diagonal, will differ from the strategic objectives of a standard automaker, which is located at the diagonal. Rolls-Royce, they suggested, uses a jumbled flow process in a high-volume, few-varieties market to achieve the strategic objectives of product customization and market niche establishment/maintenance. The standard automaker uses a connected flow process in the same market to achieve the strategic objectives of minimal manufacturing cost and market share growth/maintenance. These two examples imply that the strategic objectives of firms may vary according to

the market and manufacturing process in which they are involved.

Hayes and Wheelwright [1979a, 1984] have labeled particular strategic concerns across both the product and process life cycles within the context of the "product-process matrix." They show how strategic concerns including the priorities (considered strategic objectives by this research), key management tasks, and competitive modes alter over the course of both life cycles. Figure 2.6 shows the strategic concerns emphasized in the different manufacturing processes and market scenarios of Hayes and Wheelwright [1979a, 1984].

Several research questions arise from Hayes and Wheelwright's [1979a, 1984] discussion of strategic concerns. The first question is, "Do firms using the same manufacturing process in the same marketing conditions have similar strategic objectives?" For instance, do Rolls Royce and Bavarian Motor Works (BMW), another automaker having a market niche and using a jumbled flow process, pursue similar strategic objectives? Hayes and Wheelwright suggested that they do. The second question is, "Do strategic objectives vary between different markets and manufacturing processes?" Does a standard printing company using a jumbled flow process in a low volume, one-of-a-kind market have different strategic objectives than a sugar refinery using a continuous process in a high volume,

commodity product market? Again, Hayes and Wheelwright suggested that they do. The third question is, "Are strategic objectives inherent to particular "product-process matrix" regions?" As an example, do the strategic objectives of the region associated with disconnected flow manufacturing in a low volume, multiple varieties market vary from the strategic objectives of the region associated with connected flow manufacturing in a high volume, few varieties market? Although they did not specifically give strategic objectives by "product-process" regions, Hayes and Wheelwright implied that they do. Research is needed to investigate these three questions.

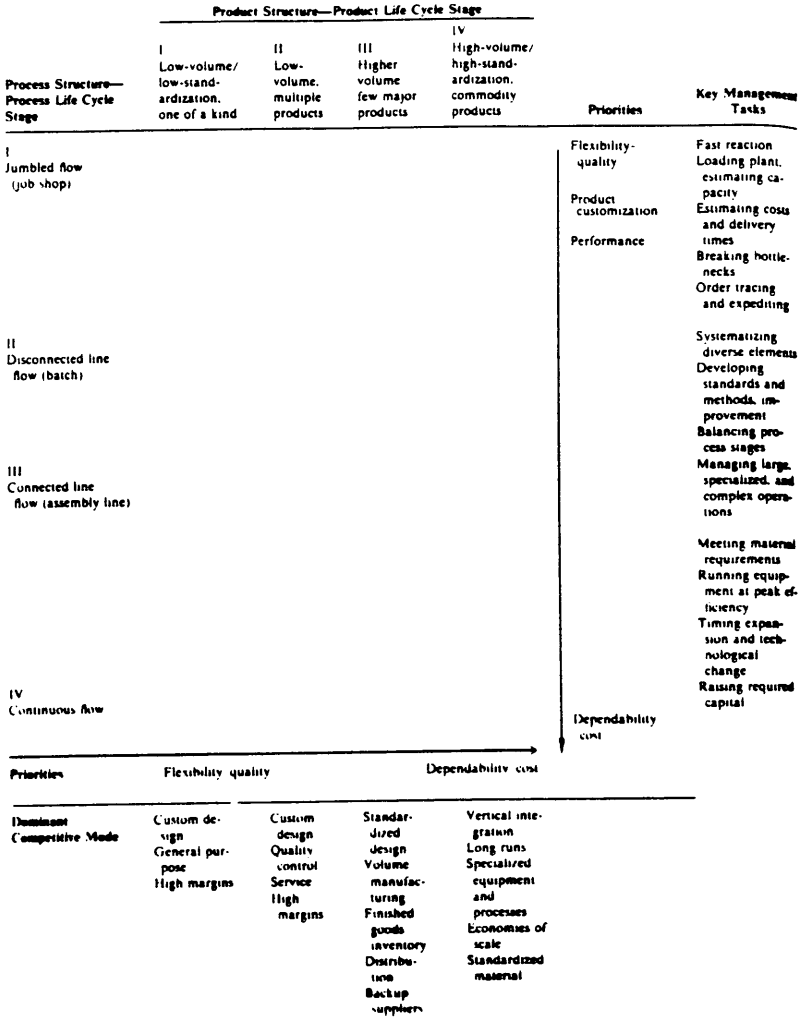


Figure 2.6: Strategic Concerns Shown Within the Structure of the "Product-Process Matrix"

[Source: Hayes and Wheelwright 1979a]

2.4.3 Limitations of the "Product-Process Matrix"

The limitations behind the "product-process matrix" are somewhat a result of the limitations found with the product

life cycle and process life cycle. As previously mentioned, the product life cycle has had controversy surrounding its validity and its simplistic representation of the market. The process life cycle is criticized for suggesting that a manufacturing process will undergo four distinct stages.

Although these criticisms are well-founded, it is often the case that any framework, like a "product-process matrix," is unable to model all scenarios. The matrix is the only model identified that attempts to illustrate the interaction between manufacturing and the market, supporting its usefulness. Taking into account that these limitations exist within its theoretical constructs, this research will still employ the "product-process matrix" in order that it can be tested and "enhanced" by placing strategic objectives within the construct of the matrix.

2.5 Strategy

2.5.1 Introduction

Although strategy has been previously discussed with the "product-process matrix," it has not been clarified as to what perspective of strategy is to be addressed by this research, nor has an in-depth description of strategy been provided. This section will define "strategy" and serve to

narrow what strategy levels and degrees of strategic concern are to be considered.

2.5.2 Corporate Strategy

Strategy, as defined for this research, is the plan of action to be undertaken by the company. Hayes and Wheelwright [1984] present three levels of strategy, which include the top level or corporate strategy, the middle level or business strategy, and the lower level or functional strategy. At the top level, corporate strategy determines the business activities in which the company will engage in addition to decisions regarding acquisitions and allocations of resources. At the middle level, business strategy determines strategies relating to scope and direction of business units. These strategies center on how the business unit will achieve and maintain a competitive advantage. At the lower level, functional strategy identifies the actual activities which will be pursued in order that a competitive edge will be obtained. These activities include the actions to be taken by marketing, manufacturing, research and development, accounting, and finance. See Figure 2.7 for a pictorial of this hierarchy.

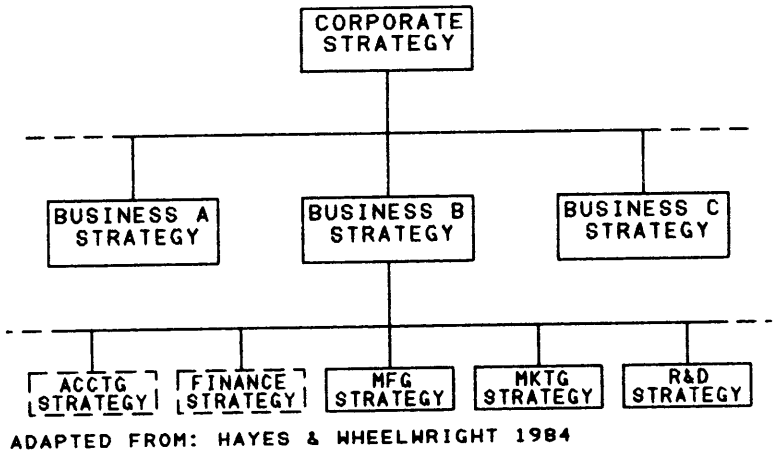


Figure 2.7: The Three Levels of Strategy

Although the "product-process matrix" has applicability to all strategic levels, this research will focus upon the functional level of strategy: manufacturing, marketing, and research and development. Since these three functions serve as the research focus, a discussion of strategies for each of these functions follows.

2.5.3 Manufacturing Strategy

Manufacturing strategy is the sum of all the actions and decisions impacting the manufacturing function of the business unit. Literature by Skinner [1969], Hayes and Wheelwright [1984], and Fine and Hax [1985] suggest different models for formulating manufacturing strategy. Although each model is different, the areas identified by

the models as manufacturing concerns are similar. These areas include process capacity, process flexibility, product and process quality, and process technology. By identifying these areas, a list of strategic objectives pertinent to the manufacturing function does not need to be developed afresh. Strategic objectives for manufacturing are synthesized from the literature. These objectives are:

- **Dependability** -- ability of manufacturing to remain operational by minimizing downtime.
- **Flexibility** -- ability of manufacturing to satisfy a diverse product line.
- **Manufacturing Cost Control** -- ability to maintain control over manufacturing costs.
- **On-time Delivery** -- ability to meet due dates.
- **Quality** -- ability to produce a quality product.
- **Responsiveness** -- ability of manufacturing to produce a new product in minimal time.

This research identifies these strategic objectives as potential primary objectives for the manufacturing function.

2.5.4 Marketing Strategy

Marketing focuses upon the proliferation and logistical support of the product in the marketplace. To perform these functions, marketing must develop a portfolio of marketing strategies to insure market success and profitability for

the company. McCarthy [1982] notes that these strategies pinpoint the target market, the market in which the product will be implanted, and establish a marketing mix, which are the controllable variables that the company puts together to satisfy the target market. These controllable variables include the resources and objectives of the firm.

Marketing strategies are derived from strategic objectives set when identifying the target market and the marketing mix. Guiltinan and Paul [1988] offer six such strategic objectives that a firm will pursue when developing an appropriate marketing program. These objectives, which will serve as the marketing objectives for this research, are:

- **Establish Initial Market Position** -- establish market for new product forms or new product brands.
- **Establish Market "Niche"** -- focus on small segment of the market which has unique needs.
- **Improve Market Share** -- increase current market share.
- **Improve Profit Margins** -- increase current profit margins.
- **Maintain Market Share** -- hold current market position.
- **Harvest** -- gradually withdraw marketing resources without dramatic impact on current sales volume.

This research identifies these strategic objectives as the list of potential primary objectives for the marketing function.

2.5.5 Research and Development Strategy

Research and development focuses upon both product and process innovations. Product innovation can lead to new or improved products for marketing, thereby allowing marketing a strategic advantage in the marketplace. Process innovation can lead to the development of improved manufacturing and/or materials, resulting in the reduction of overall manufacturing costs.

Glueck and Jauch [1984] divide research and development into five categories: exploratory research, new product or process research, improvement research, cost reduction research, and raw material adaptation research. Depending upon the company's direction, these categories will vary in importance.

From the standpoint of this research, strategic objectives will only pertain to the more general categories of process and/or product research and development (R&D). These categories are explained below:

- **Process R&D** -- research and development activities focused upon process improvement and new process techniques/technologies.

- **Product R&D** -- research and development activities focused upon product improvements including new product designs and materials.
- **Both Types of R&D** -- both types of R&D activities performed with equal emphasis.
- **No R&D activities** -- no R&D activities undertaken.

This research identifies these strategic objectives as the potential primary objectives for the research and development function.

2.6 Strategy Over Product and Process Life Cycles

2.6.1 Introduction

Both strategic management literature and the "product-process matrix" suggest that strategic objectives (priorities) will change over time. Although this research will not perform a longitudinal study of strategic objectives, regions across the "product-process matrix" will be compared to assess if certain strategic objectives take precedence within particular regions. With the "product-process matrix" having its concept rooted in the product life cycle and process life cycle, generalizations as to transition over both rows (process life cycle) and columns (product life cycle) will be made. Before such generalizations are formulated, it is necessary that an

assessment of literature concerning the transition of strategic objectives be made.

2.6.2 The Transition of Strategic Objectives Over The Product Life Cycle

2.6.2.1 Introduction

Despite the fact that life cycle literature is relatively new, literature concerning the transition of strategy over the product life cycle has been published, specifically in the area of marketing. Recently, the product life cycle concept has been extended beyond the traditional marketing orientation to the areas of manufacturing and research and development. Each of these three areas are discussed below.

2.6.2.2 The Transition of Marketing Strategic Objectives

The transition of marketing strategy has been discussed by Luck [1972], Fox [1973], Wasson [1974], Hofer [1975], Anderson and Zeithaml [1984], and Cavinato [1987]. Topics have included advertising, distribution, logistical support, and selling. Such topics, though, have been more oriented towards what strategies (activities) to follow than what strategic objectives to establish. Hax and Majluf [1984],

however, present some suggested strategic objectives for marketing. Using a matrix format offered by Arthur Little, Inc., and entitled the "life-cycle portfolio matrix," Hax and Majluf present five levels of competitive position. These five levels are:

- **Dominant** -- the company is the standard for the market.
- **Strong** -- the company has a definite advantage over its competitors, but is not dominant.
- **Favorable** -- the company is unique within the market as in the case of a market niche or differentiation.
- **Tenable** -- the company has some slight difficulty in gaining and/or retaining market share although in fairly stable position.
- **Weak** -- the company is in an unstable market position which cannot be sustained in the long run.

Using these levels of competitive position, market share objectives were assigned by Hax and Majluf [1984] over the course of the product life cycle. This matrix serves as a foundation for establishing strategic objectives within the "product-process matrix" for various competitive positions. The "life-cycle portfolio matrix" of Arthur Little, Inc., asserts that competitive position is important to the determination of strategic objectives. This suggests that strategic objectives may vary according to competitive position. As is true with the "product-process matrix", the "life-cycle portfolio matrix" does not have empirical

evidence, but it does serve as a unique theoretical construct. The "life-cycle portfolio matrix" is exhibited in Table 2.1.

Table 2.1: The "Life-Cycle Portfolio Matrix"

[Source: Hax and Majluf 1984]

	INTRO	GROWTH	MATURITY	AGING
DOMINANT	-All out push for market share -Hold position	-Hold position -Hold market share	-Hold position -Grow with industry	-Hold position
STRONG	-Attempt to improve position -All out push for market share	-Attempt to improve position -Push for market share	-Hold position -Grow with industry	-Hold position or -Harvest
FAVORABLE	-Selective or all out push for mkt share -Selectively attempt to improve position	-Attempt to improve position -Selective push for market share	-Custodial or maintain strategy or -Find "niche" and attempt to protect it	-Harvest or -Phased withdrawl
TENABLE	-Selectively push for position	-Find "niche" and protect it	-Find "niche" and hang on or -Phased withdrawl	-Phased Withdrawl or -Abandon
WEAK	-Either up or out	-Turnaround or -Abandon	-Turnaround or -Phased withdrawl	-Abandon

Using the matrix and the previously-stated primary marketing strategic objectives of this research, a revision of the "life-cycle portfolio matrix" was made. Revisions were made by substituting the primary marketing objectives given by this literature review in place of the objectives suggested by Hax and Majluf. The new matrix shows the theoretical transition of primary marketing strategies

pertinent to this research [see Table 2.2]. This research tested the appropriateness of these strategies.

Table 2.2: Revised "Life-Cycle Portfolio Matrix"

[Adapted From: Hax and Majluf 1984]

	INTRO	GROWTH	MATURITY	AGING
DOMINANT	-Establish initial market position	-Market share maintenance -Cash flow maximization	-Market share maintenance -Cash flow maximization	-Market share maintenance -Cash flow maximization
STRONG	-Establish initial market position	-Market share growth	-Market share maintenance -Cash flow maximization	-Market share maintenance -Cash flow maximization
FAVORABLE	-Selectively establish initial market position	-Market share growth	-Market share maintenance -Market "niche"	-Harvesting
TENABLE	-Selectively establish initial market position	-Market "niche" -Market share growth	-Market "niche" -Harvesting	-Harvesting
WEAK	-Establish initial market position	-Market "niche" -Market share growth	-Market share growth -Market "niche" -Harvesting	-Abandon

2.6.2.3 The Transition of Manufacturing Strategic Objectives

Manufacturing strategies have been discussed by Fox [1973], Hofer [1975], and Anderson and Zeithaml [1984]. These authors have addressed particular strategies with respect to cost, flexibility, capital intensity, and vertical integration, giving minimal attention to strategic objectives. Hayes and Wheelwright [1979a, 1979b, 1984],

though, present strategic objectives in their "product-process matrix" literature. Unlike Hax and Majluf [1984], who provide six levels of competitiveness through the four stages of the product life cycle, Hayes and Wheelwright only address a single level without placing strategic objectives within particular product life stages. As yet, no literature has been located that discusses the influence of competitive position upon the manufacturing strategic objective.

It is suggested by Hayes and Wheelwright [1979a, 1979b, 1984] that in the early stages of the product life cycle, the strategic objectives will center upon flexibility and quality. In the later stages, dependability and cost will become the emphasis. This research investigates whether these strategies are actually stressed in the order they are hypothesized. This research also investigates whether there are alternative manufacturing strategic objectives being utilized.

2.6.2.4 The Transition of R&D Strategic Objectives

Research and development strategies pertain to the emphasis on product and process R&D. Strategies have been suggested by Fox [1973], Hofer [1975], Anderson and Zeithaml [1984], and Canada and Sullivan [1989]. These suggested strategies are representative of the R&D strategic

objectives, which are to be addressed by this research. In the introduction stage, product R&D is emphasized by the company. Upon entering the growth stage, the objective is a combination of both product and process R&D. In the maturity stage, process R&D becomes the focus, while product R&D shifts to new products. The decline stage uses little or no R&D activities unless such activities will promote profitability since efforts are concentrated on newer products.

This research investigates the appropriateness of these R&D strategic objectives, which are suggested by literature. In addition, this research determines if alternative R&D strategic objectives are being used.

2.6.3 The Transition of Strategic Objectives Over the Process Life Cycle

An extensive search of literature has revealed that there has been limited research on the transition of strategic objectives over the course of the process life cycle. As yet, only work by Abernathy and Townsend [1975] and Hayes and Wheelwright [1979b, 1984] has been located. Their work has focused strictly on manufacturing strategic objectives, where the manufacturing function emphasizes flexibility and quality in the early stages of the process life cycle. In the middle stages, the manufacturing

function emphasizes product customization (responsiveness) and performance (dependability). In the later stages, the manufacturing function focuses upon cost.

No theories have been offered for marketing and R&D over the process life cycle. It is believed that this research is the first attempt to identify strategic objectives for these functions over stages of the process life cycle.

2.7 Summary of Literature Review

The cornerstone of this research is the framework of the "product-process matrix." This literature review has discussed the theoretical constructs composing this framework in order to support its use as a research tool and establish an understanding of the concept. The literature review also presented the strategic objectives of manufacturing, marketing, and R&D and discussed the transition of these strategic objectives. Appendix A shows a compilation of these strategic objectives and displays their transition over both the product life cycle and process life cycle.

Chapter 3

Objectives, Scope, and Assumptions

3.1 Introduction

The literature review included discussions of the concepts of the product life cycle, process life cycle, and "product-process matrix." In addition, the literature review identified strategic objectives for the functions of manufacturing, marketing, and R&D and suggested that such strategic objectives change over product and process life cycles. This research addresses the questions surrounding the appropriateness of these strategic objectives and their transition. This research also addressed questions surrounding the "product-process matrix." Questions included "What are the feasible regions of the matrix?" and "What are the similarities between firms within each of these feasible regions?"

3.2 Objectives

The objective of this research was to analyze strategic objectives for firms over different market/process regions within the "product-process matrix." It was hypothesized that such objectives will change between regions. This research also intended to investigate whether firms having the same manufacturing process and market would have similar strategic objectives. Currently, no theories surround this issue of similarity. It was the intention that at the conclusion of this research, theories concerning similarity of strategic objectives could be constructed using an inductive approach. To perform these investigations, a survey was employed to assess strategic objectives currently being emphasized by manufacturing facilities in Virginia.

The specific objectives to be pursued by this research were to determine a set of appropriate strategic objectives, identify feasible regions within the "product-process matrix," determine similarities of firms within feasible regions of the "product-process matrix," and assess the applicability of the transition of strategic objectives.

The first specific research objective was to determine primary strategic objectives that are being utilized by manufacturing facilities. This was accomplished by compiling the survey responses concerning strategic objectives. Those strategic objectives listed by this

research as primary objectives, but not identified by facilities to be primary, were assumed to be inappropriate as a primary strategic objective. Those strategic objectives identified by facilities as primary, but not listed by this research as primary objectives, were assumed appropriate and were added to the current list.

The second research objective was to identify the feasible regions within the "product-process matrix." Hayes and Wheelwright [1979a, 1979b, 1984] specified that there are two particular regions which should not be occupied -- the region of a jumbled flow process in a high volume, high standardization, commodity market and the region of a continuous flow process in a low volume, low standardization, one-of-a-kind market. Conversely, Hayes and Wheelwright implied that all other regions are feasible. This research determined if this is the case by determining which regions appeared to be popular and unpopular as indicated by survey responses. It was assumed that those areas not receiving responses were associated with infeasible regions.

The third research objective was to determine similarities of firms within feasible regions of the "product-process matrix." These similarities related to the characteristics of competitive position, primary product manufactured, and the strategic objectives for manufacturing, marketing, and research and development. The

designation of similarities was based upon survey responses which fell within each of the "product-process matrix" regions. Characteristics were tallied and analyzed using the Jaccard Coefficient, a measure indicating maximum similarity between objects [see Romesburg 1984]. The average of Jaccard coefficients for individual and all characteristics within each feasible region determined similarity ratings for both individual attributes and overall similarity. The closer the average of Jaccard coefficients was to 1, the higher the similarity of measured attributes of firms within the region. Analysis focused on determining which characteristics showed high similarity within each feasible region. After similarity factors were identified, an enhanced version of the "product-process matrix" was constructed to show what strategic objectives and other firm characteristics were associated with each "product-process" region. Appendix B illustrates the calculation of similarity factors.

The fourth research objective was to assess the applicability of the transition of strategic objectives over the stages of both the product life cycle and process life cycle. This objective centered on determining the order of precedence for strategic objectives. Using those strategic objectives identified as similar for each "product-process matrix" region, an assessment of the transition for these objectives was made over both the product life cycle and

process life cycle. This transition was compared to the hypothesized transition of strategic objectives (those strategic objectives given within the literature review). Differences between the transition suggested by the survey and the hypothesized transition were noted. It was assumed that if differences existed, it could be inferred that there was limited applicability for the transition of the strategic objectives as given by the literature review.

In addition to these four main objectives, this research served as a test of validity for both the "product-process matrix" and the transition of strategic objectives. At present, there is a limited amount of empirical evidence to support either concept. This research attempted to provide such empirical evidence.

3.3 Scope

This research focused on Virginia manufacturing facilities listed in the Virginia Business Directory 1988-89, a directory which contains both Virginia businesses and manufacturing facilities. It was assumed that strategic objectives identified by Virginia manufacturing facilities within this directory would be representative of strategic objectives established by domestic facilities not located in Virginia. This research only considered domestic firms. Foreign-owned firms identified by the 1985 Virginia

Manufacturing Directory (the most recent reference identifying foreign-owned Virginia manufacturing firms) were excluded from this research since there was a possibility that strategic objectives would have been influenced by other factors not considered in this work. Future research should be performed to determine if there are variations in strategic objectives for domestic and international firms.

The scope of this research was to identify the strategic objectives for the three operation functions of manufacturing, marketing, and research and development. This research considered the primary strategic objectives to be those strategic objectives designated by the literature review. To narrow the numerous possibilities, the survey suggested to survey participants these primary strategic objectives. This may have biased results; however, the selected categories allowed for better clarification of objectives. The survey was sent to the general manager of each firm.

3.4 Assumptions

Several assumptions were made in this research. These assumptions were:

- Virginia manufacturing facilities were assumed representative of all domestic manufacturing facilities.

- The company official filling out the survey understood and was knowledgeable of the strategic objectives of the firm.

- Strategic objectives selected by the firm were actually what they were practicing.

- Products manufactured by firms in Virginia were representative of products being manufactured in the U.S.

- Markets and processes could be represented by life cycles.

Chapter 4

METHODOLOGY

4.1 Course of Action

As stated in the objectives, this research investigated four research issues: the appropriateness of the given primary strategic objectives, feasibility of regions within the "product- process matrix," similarities of firms within these regions, and the applicability of the given transition of strategic objectives. To perform this investigation, a survey was sent to general managers of Virginia manufacturing facilities to assess strategic objectives for the operating functions of manufacturing, marketing, and research and development. With the format of the survey being a check-the-answer format, it was hoped that the response rate to this one-page survey would be high, and that response would be rapid.

Research began with the construction of a suitable survey while simultaneously constructing a company database. The company database was constructed using DBase III+ computer software and consisted of information about

manufacturing facilities listed in the Virginia Business Directory 1988-89; these data were loaded into the DBase III+ database. Information loaded into the database included the manufacturing facility name, address, phone number, employment size code, sales volume code, and the standard industry code (SIC code) of the primary product category being manufactured.

Using this database, mailing lists were generated, and subsequently, surveys were sent to the company's general manager. Upon the return of surveys, information was loaded into the database to update the firm's record. The date of March 24, 1989 was the requested deadline for the receipt of surveys.

Analysis of the survey consisted of grouping surveys by "product-process matrix" regions. This was done by assessing the survey responses of process type and market type. Following the grouping of firms, an assessment of strategic objectives for each function was made. If similarities were inherent to particular regions within the matrix, conclusions were made regarding the appropriateness and applicability of strategic objectives over product and process life cycles. These conclusions regarding similarity of objectives were used to construct theories regarding strategic objectives and their transition. Such theories were used to enhance the "product-process matrix" by

addressing strategic objectives within particular "product-process matrix" regions.

A detailed course of action for this research was as follows:

1. Constructed a one-page survey.
2. Constructed company database using 1988-89 Virginia Business Directory.
3. Generated mailing labels.
4. Sent out surveys.
5. Loaded returned survey data into the company database.
6. Compiled and compared the strategic objectives of manufacturing, marketing, and research and development.
7. Grouped manufacturing facility data by "product-process matrix" regions.
8. Determined feasible regions within the "product-process matrix."
9. Assessed similarities of strategic objectives and firm characteristics within "product-process" region.
10. Assessed applicability of given (hypothesized) strategic objectives transition to the transition suggested by survey results.
11. Made observations and drew conclusions.

4.2 The Survey

According to the Virginia Business Directory, there are 5,384 different products manufactured within Virginia.

Since there were no previous data to calculate a specific sample size, the sample size was determined subjectively as suggested by the Social and Community Planning Research Institute [1973]. Arbitrarily, a survey sample size of 410 was used. This sample size was equivalent to 8% of the total of products manufactured within Virginia.

Surveys were sent to manufacturing facilities at random. The sample, however, was representative of the product mix within Virginia. This was accomplished by proportioning surveys among manufacturing facilities in accordance with the degree to which that product is manufactured within Virginia. This was done by calculating fractions for each Standard Industry Code (SIC code) listed in the directory and then multiplying each SIC code fraction by 410. Structuring the sample in this fashion prevented uncommon products from influencing survey results and allowed common products to be fairly represented.

The survey itself [see Appendix C] consisted of seven sections. The first section identified the type of product category market in which the firm is involved. The five categories were:

- Low volume, low standardization, one-of-kind products
- Multiple variety, low volume products
- Few major variety, high volume products
- High volume, high standardization, commodity products
- "Other" [market of product category not described by the above categories]

The second section examined the competitive position of the firm. Each category described a different competitive position. These descriptions were:

- Standard for the market: dominant position
- Product's position has a definite edge over competitors, but it is not dominant
- Product is unique within the market due to a market niche or market differentiation
- Slight difficult in gaining and/or retaining market share although product is in fairly stable position
- Unstable product position which may not be sustained in the long run
- "Other" [competitive position not listed]

The third section of the survey addressed the type of process being used. Five categories were offered: 1) job shop process, 2) batch flow process, 3) assembly line, 4) continuous flow process, and 5) other. Each of these categories had these descriptions:

- **Job Shop** -- focus on work centers. Equipment and labor force has flexibility in manufacturing different products.
- **Batch Flow** -- production follows loose standard flow pattern. Equipment and labor specialized in certain tasks.
- **Assembly Line** -- equipment and labor are dedicated to particular tasks. Tasks are synchronized to produce overall product(s). Production follows a definite flow pattern.
- **Continuous Flow** -- production dedicated to primary product using highly mechanized, standardized, and/or automated process. Equipment and labor highly specialized and dedicated to specific tasks.
- **"Other" Category** -- [process not listed]

The fourth section of the survey addressed the strategic objective of the manufacturing function. Candidate objectives were defined as previously presented. Only one selection was allowed. The manufacturing strategic objectives were as follows:

- **Dependability** -- focus on remaining operational by minimizing downtime.
- **Flexibility** -- focus on satisfying a diverse product line.
- **Manufacturing Cost Control** -- maintain control over manufacturing costs.
- **On-time Delivery** -- focus on meeting due dates.
- **Quality** -- focus on producing a quality product efficiently.
- **Responsiveness** -- focus on producing a new product in minimal time.
- **"Other" Category** -- [objective not listed]

The fifth section addressed the marketing strategic objective. Again, the previously defined marketing strategic objectives were used with only one selection possible. The strategic objectives of marketing were:

- **Establish Initial Market Position** -- establish market for new product forms or new product brands.
- **Establish Market "Niche"** -- focus on small segment of the market which has unique needs.
- **Improve Market Share** -- increase current market share.
- **Improve Profit Margins** -- increase current profit margins.
- **Maintain Market Share** -- hold current market position.
- **"Other" Category** -- [objective not listed]

The sixth section addressed the research and development strategic objective. Only one selection was allowed. The strategic objectives of research and development, which were previously presented, were:

- **Process R&D** -- activities focused upon process improvement and new process techniques/technologies.
- **Product R&D** -- activities focused upon product improvements including new product designs and materials.
- **Both Types of R&D** -- equal emphasis on both types of R&D.
- **No R&D activities** -- no R&D activities are undertaken.
- **"Other" Category** -- [objective not listed]

The seventh and final section served as a comment section for additional information, which the respondent might have liked to provide. Appendix C contains the survey and cover letter, which were used.

4.3 Company Database

The company database, entitled VAMFGS, contained descriptive data of the manufacturing facilities being surveyed. These data, which came from the Virginia Business Directory 1988-89, included the firm name, address, phone number, standard industry code (SIC code), and codes representing categories of employee size and sales volume. The database also contained the results of the survey. These results were loaded into the database in numerical form to represent the particular responses in order to facilitate analysis of survey responses. Responses of "other" were loaded into both numerical and comment fields. Table 4.1 shows the structure of the database.

One advantage of having constructed this database is that future research can easily access the DBase III+ database to retrieve information on particular industries by using the SIC code field. This will eliminate interaction with the mainframe computer. Programs can also be written to generate mailing lists from the database. This will facilitate groundwork for future survey activities.

Table 4.1: Structure of the VAMFGS Database

```
Structure for database: C:VAMFGS.dbf
Number of data records:     410
Date of last update    : 03/25/89
Field  Field Name  Type       Width
    1  FIRM        Numeric        3
    2  NAME        Character     30
    3  ADDRESS     Character     30
    4  CITY        Character     25
    5  STATE       Character      2
    6  ZIPCODE     Numeric        5
    7  PHONE       Character     12
    8  EMPCODE     Character      1
    9  SALESCODE   Character      1
   10  SICCODE     Numeric        4
   11  Q1          Numeric        1
   12  Q2          Numeric        1
   13  Q3          Numeric        1
   14  Q4          Numeric        1
   15  Q5          Numeric        1
   16  Q6          Numeric        1
   17  COMMENTS    Memo          10
** Total **                     130
```

4.4 Analysis of Survey Data

Survey data were tallied to calculate the make-up of the survey sample. Similarity of survey data was evaluated using calculations of the Jaccard coefficient of similarity. This was suggested by Romesburg [1984], who showed examples of using the Jaccard coefficient on ordinal data. The Jaccard coefficient, which ranges from 0 to 1, infers no similarity when close to 0 and maximum similarity when close to 1. The higher the regional Jaccard coefficient was, the

more it was inferred that similarity existed within the region.

Similarity analysis consisted of calculating the averages of Jaccard coefficients between individual firms within particular regions of the "product-process matrix." Similarity was judged for three cases: seven data items from a product specific standpoint, seven data items from an industry standpoint, and four survey questions. The seven data items were competitive position, manufacturing objective, marketing objective, R&D objective (all gathered from the survey responses), and employee size code, sales volume code, and SIC code (all gathered from the Virginia Business Directory 1988-89). Product-specific similarity was calculated by comparing the four numbers of the SIC code between firms. Industry-specific similarity was calculated by comparing only the first two numbers of the SIC code. The four survey question similarity factor used the responses of competitive position, manufacturing objective, marketing objective, and R&D objective between firms. Once similarity factors were calculated, the transition of strategic objectives between "product-process matrix" regions was compared to the given (hypothesized) transition of strategic objectives. A Jaccard coefficient between the survey's suggested strategic objectives and the hypothesized strategic objectives was calculated.

Analysis of the three similarity factors does not only address the magnitude of similarity within the region, but also what type of similarity exists within the "product-process matrix" region. If the product-specific or industry-specific similarity factor is larger than the survey question similarity factor, it is inferred that there is greater similarity with respect to firm attributes. If the opposite is true, it is inferred that there is greater similarity with respect to strategic objectives. Comparison of the product-specific and industry-specific similarity factors reveals if similar products are being manufactured within the region. This is inferred if the industry-specific similarity factor is greater than the product-specific similarity factor since there are matches with respect to product category (represented by the first two numbers of the SIC code). If both the product-specific and industry-specific similarity factors are equivalent, then it may be inferred that there are no similar products in the region.

The assessment of similarity factors is limited, however. Several of the "product-process matrix" regions have small totals, making the similarity factor inconclusive. Even though similarity factors are calculated for regions with totals greater than one (similarity cannot be calculated for a single firm), it is proposed that the conclusiveness of calculated factors increases with the

response size of the region. Similarity factors from regions with low totals (especially those regions with totals under 5) cannot realistically be used to support conclusions relating to similarity.

Chapter 5

Survey Results

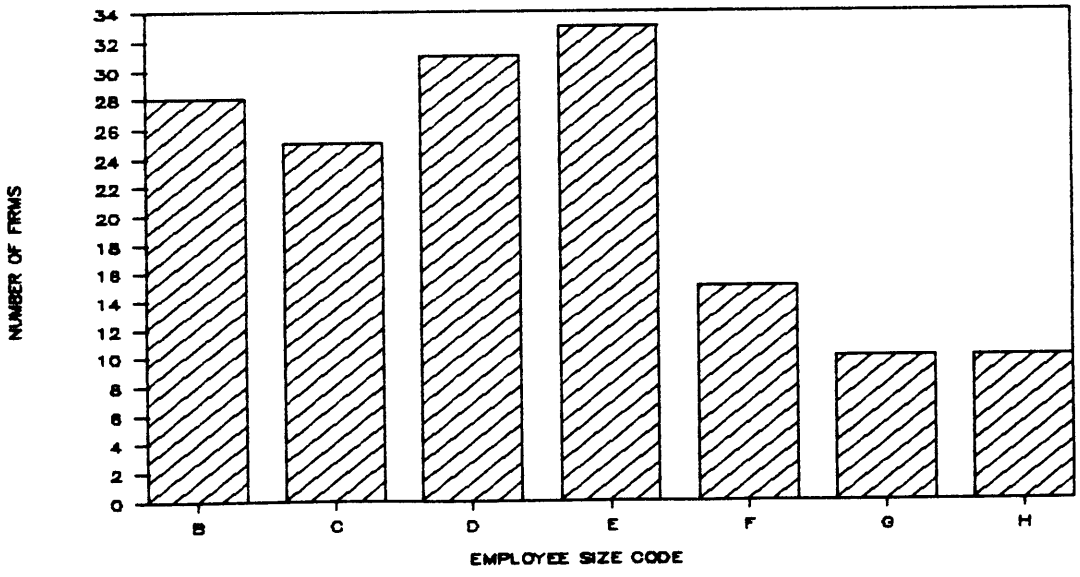
5.1 Introduction

This chapter presents the results of the survey. The chapter begins with a description of the survey response group. Next, survey response totals are given from both the standpoints of overall and individual "product-process matrix" regions. A discussion of these response totals is then provided.

5.2 Response Group

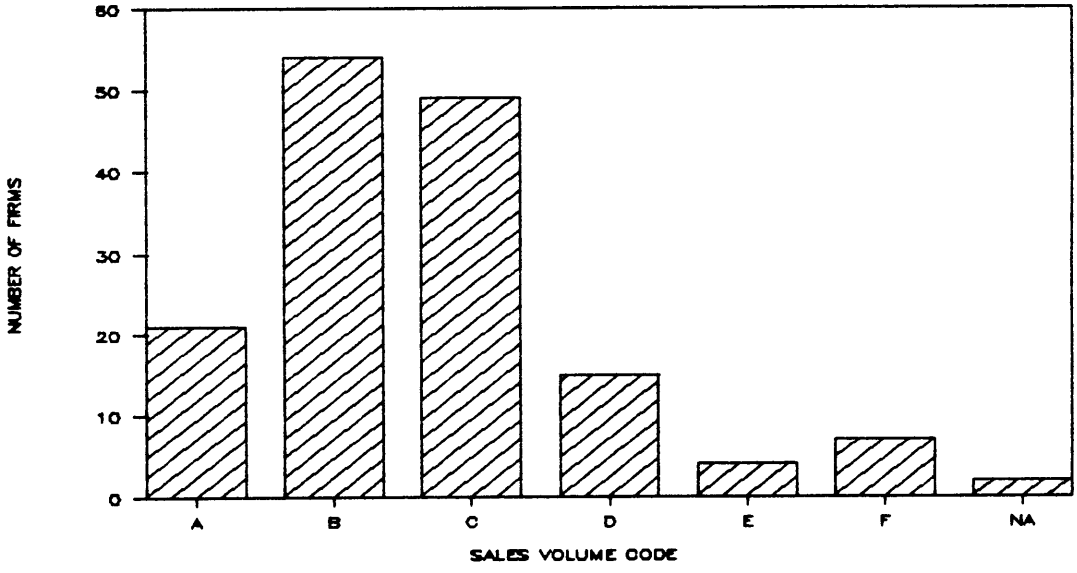
A total of 152 usable surveys were returned by March 24, 1989, out of the original 410 that were sent. This corresponds to a response rate of 37%. Forty-four surveys were unusable: 33 surveys could not be delivered, 9 surveys reported that no manufacturing was being performed presently at the facility, and 2 surveys responded that the firm was out of business.

The response group was diverse with 104 different products being represented (the sample of 410 represented 206 different products). Facility employment sizes ranged from the 10-24 employees size bracket to the over-1000 employees size bracket (see Figure 5.1). Facility sales volume ranged from the up-to-$1 million category to the over-$100 million category (see Figure 5.2). Responses existed for all "product-process matrix" regions.



KEY: B = 10-24, C = 25-49, D = 50-99, E = 100-249, F = 250-499, G = 500-999, H = >1000

Figure 5.1: Distribution of Employment Size For Survey Response Group



KEY (in millions): A = $0-1, B = $1-5, C = $5-20, D = $20-50
E = $50-100, F = >$100, NA = not available

Figure 5.2: Distribution of Sales Volume For Survey Response Group

5.3 Overall Responses

An analysis of all responses found that 32% of responding firms felt that they were in a strong market position. The most-often-cited strategic objectives used to obtain and maintain competitiveness were quality for manufacturing (47%), improve market share for marketing (51%), and either no R&D or product R&D for research and development (30%).

Responses to Question Two, which related to competitive position, showed that close to one-third of the respondents felt that they were in a strong position. The strong position had a 3-to-2 edge over the next most selected positions, which were dominant and tenable. Firms selecting "other" did not suggest alternative positions. Instead, firms answering "other" gave the actual market share held by the firm. One firm answered "other" giving the reason that no proprietary products were manufactured at the facility. Competitive position responses were dispersed as follows:

Competitive Position	# of Responses
Dominant	33
Strong	48
Favorable (unique)	30
Tenable (slight)	33
Weak (unstable)	2
Other*	6

* Other included no responses and firms stating % market share.

Almost half of the responses to the question concerning primary manufacturing strategic objective, which was Question Four, was quality. Time compression/management was the only alternative manufacturing objective offered. The remaining "other" responses were from firms stating that they pursued a combination of the given primary

manufacturing strategic objectives. The distribution of responses was as follows:

Manufacturing Objective	# of Responses
Dependability	13
Flexibility	22
Cost Control	20
On-time Delivery	17
Quality	71
Responsiveness	2
Other*	7

* Other included no responses, multiple objective responses, and time compression/management.

Over half of the responses to the question of primary marketing strategic objective, which was Question Five, was improve market share. Repositioning was the only alternative marketing objective suggested. The remaining two "other" responses were firms pursuing a combination of marketing strategies from the given list. Primary marketing objective responses were as follows:

Marketing Objective	# of Responses
Establish Initial Position	2
Establish Market "Niche"	28
Improve Market Share	77
Improve Profit Margins	25
Maintain Market Share	17
Other*	3

* Other included repositioning and multiple objective responses.

No dominant primary R&D strategic objectives were identified. The two strategic objectives no R&D and product R&D were the most selected answers with each having the same number of responses. No "other" responses were given. The distribution of R&D objective responses was as follows:

R&D Objective	# of Responses
No R&D Performed	45
Process R&D	32
Product R&D	45
Both Types of R&D	30

5.4 Categorization by "Product-Process Matrix" Regions

Grouping by product and process type, responses were placed within particular regions of the "product-process matrix." To assist in their identification, these regions were labeled as given in Table 5.1.

Table 5.1: Labels Given To "Product-Process Matrix" Regions

	Low Volume, One-of-a-Kind	Low Volume, Multi-Variety	High Volume, Few Varieties	High Volume, Commodity
Jumbled Flow	(1,1)	(2,1)	(3,1)	(4,1)
Disconnected Flow	(1,2)	(2,2)	(3,2)	(4,2)
Connected Flow	(1,3)	(2,3)	(3,3)	(4,3)
Continuous Flow	(1,4)	(2,4)	(3,4)	(4,4)

Only 138 survey responses out of the 152 total responses fit within the construct of the "product-process matrix." Response totals for each of the regions are provided in Table 5.2. The remaining 14 survey responses were "other" responses to either (or both) question(s) concerning product and process structure. "Other" responses included multiple markets being pursued by the primary product category and multiple processes being required to manufacture a primary product category. No new manufacturing or market structures were suggested by the respondents.

Table 5.2: Responses Totals Per "Product-Process Matrix" Region

	Low Volume, One-of-a-Kind	Low Volume, Multi-Variety	High Volume, Few Varieties	High Volume, Commodity
Jumbled Flow	4	33	5	1
Disconnected Flow	5	23	8	4
Connected Flow	3	8	11	5
Continuous Flow	1	4	6	17

The groupings of responses showed no regions within the "product-process matrix" to be "void." This was contrary to Hayes and Wheelwright's theory that there are "void" regions. It was shown, though, that the "void" regions suggested by Hayes and Wheelwright, region (1,4) and region (4,1), were unpopular. One firm involved in the fabricated metals industry claimed to occupy region (1,4). A firm involved in the printing industry claimed to occupy region (4,1). Although these firms claimed to be in these regions, it is conceivable that these two firms may have misplaced themselves within the matrix structure by either improperly selecting their market and/or manufacturing process. Bias associated with the survey instrument also may have

contributed to firms improperly identifying themselves with a "void" region.

The most popular region was region (2,1), which is associated with multiple variety products of low volume using jumbled flow (job shop) manufacturing. This region was also identified as the matrix's center of gravity (center of gravity was determined by identifying the region having the greatest row and column totals). The popularity of this region and its being the center of gravity was interesting since Hayes and Wheelwright [1979a, 1979b, 1984] suggest that the majority of firms should fall along the diagonal, that is, into the four regions (1,1), (2,2), (3,3), and (4,4). The grouping of survey responses showed that firms fall along the diagonal later in the product life cycle, but that in the early stages, firms were slightly off the diagonal. This was supported by the highest number of responses in the first stage of the product life cycle (low volume, one-of-a-kind products) being in the region using disconnected flow manufacturing and the second stage (low volume, multiple variety products) being in the region using jumbled flow (job shop) manufacturing.

Analysis into the popular strategic objectives of firms within the different regions also showed interesting results. Before these results are presented within the construct of the "product-process matrix," response totals for each individual region are described.

5.4.1 Region (1,1)

Four firms were identified as occupying region (1,1), which is the region associated with low volume, one-of-a-kind products using jumbled flow (job shop) manufacturing. Firms responding were involved in the apparel products, wood products (not including furniture), and industrial/commercial machinery industries. Three of four firms had employment of between 25 and 49 employees; the other firm has employment of between 50 and 99 employees. All four firms had sales volumes between $1 and $5 million.

A majority of these firms listed their competitive position as being favorable (unique). The most popular strategic objectives were quality for manufacturing, improve profit margins for marketing, and no R&D for research and development. Region totals were as follows:

Question	Answer	# of Responses
Competitive Position	Dominant	1
	Strong	1
	Favorable (unique)	2
Manufacturing Objective	Dependability	1
	Quality	3
Marketing Objective	Establish "Niche"	1
	Improve Margins	2
	Maintain Share	1
R&D Objective	No R&D Performed	3
	Both Types of R&D	1

Similarity factors for the region were calculated to be .405 for the seven data items (product-specific), .429 for the seven data items (industry-specific), and .333 for the four survey questions (see again Section 4.4 for a discussion of the similarity factors used). This suggested that firms within this region were more similar with respect to firm characteristics than firm objectives.

5.4.2 Region (1,2)

Five firms were identified as occupying region (1,2), which is associated with low volume, one-of-a-kind products using disconnected flow (batch) manufacturing. All firms came from different industries. These industries included food products, printing, fabricated metals, transportation equipment, and photographic equipment. One firm had employment of 10 to 24 employees, while three firms had employment of between 25 and 49 employees. The remaining firm had an employee size of 100 to 249 employees. All five firms had sales volumes between $1 and $5 million.

Respondents from firms in this region identified their firm's competitive position as being favorable (unique). The most popular objectives were the manufacturing objective of quality, marketing objective of improve market share, and R&D objective of product R&D. Response totals for the region were:

Question	Answer	# of Responses
Competitive Position	Dominant	1
	Strong	1
	Favorable (unique)	2
	Tenable (slight)	1
Manufacturing Objective	Dependability	1
	Cost Control	1
	Quality	2
	Responsiveness	1
Marketing Objective	Establish "Niche"	1
	Improve Share	4
R&D Objective	No R&D Performed	1
	Product R&D	3
	Both Types of R&D	1

Similarity factors of the region were .343 for the seven data items in both the cases of product-specific and industry-specific. The similarity factor was .275 for the four survey questions. It is suggested by these similarity factors that firms are more similar with respect to firm characteristics than objectives. The equality of seven data item similarity factors indicates that firms did not manufacture similar products.

5.4.3 Region (1,3)

Three firms were identified as occupying region (1,3), which is associated with low volume, one-of-a-kind products using connected flow (assembly line) manufacturing. Firms came from the three industries of food products, textile, and apparel industries. Employment size included one firm

from each of the following: 50 to 99 employees, 100 to 249 employees, and over 1000 employees. Two firms had sales volumes between $5 and $20 million; the remaining firm had a sales volume over $100 million.

No dominant competitive position or strategies for manufacturing or marketing could be established. Each of the three firms selected different answers for each of the questions. The dominant R&D strategic objective was no R&D for all firms. Response totals were as follows:

Question	Answer	# of Responses
Competitive Position	Dominant	1
	Favorable (unique)	1
	Tenable (slight)	1
Manufacturing Objective	Flexibility	1
	Cost Control	1
	Quality	1
Marketing Objective	Improve Share	1
	Improve Margins	1
	Maintain Share	1
R&D Objective	No R&D Performed	3

The region had similarity factors of .190 for the seven data items in both the cases of product-specific and industry-specific. A similarity factor of .250 was calculated for the four survey questions. These values suggest that firms in this region have more similarity among their strategic objectives, than with their firm characteristics. Note, however, that firms selected

different strategic objectives for three of the four survey questions. This would suggest that there is minimal similarity within this region. The explanation for the calculation of a .250 similarity factor is that all firms chose the R&D objective of no R&D.

5.4.4 Region (1,4)

As previously mentioned, only one firm was identified as occupying region (1,4), which is the region associated with low volume, one-of-a-kind products using continuous manufacturing and considered to be one of the two "void" regions. This firm represented the fabricated metal products industry with an employment size between 50 and 99 employees and a sales volume between $5 and $20 million. The firm identified a strong competitive position and the adherence to the objectives of quality for manufacturing, improve profit margins for marketing, and process R&D for research and development. No similarity factors could be calculated since there was only one firm within the region.

The likelihood of this firm occupying this region is debatable. Convention would lead to the conclusion that there would be cost inefficiency in producing low volume, one-of-a-kind products using a continuous process. As previously mentioned, the firm may have improperly identified its market and/or manufacturing process. On the

other hand, there is a remote possibility that a firm could occupy this region. It is offered that a firm utilizing flexible automation could maintain cost-effective manufacturing even though the one-of-a-kind market would force numerous set-ups and reduce efficiency. Another explanation is that a firm using a hybrid manufacturing process, which includes continuous processing, could have identified itself as a continuous process. Such a case could be considered an exception to the process life cycle stages given within the "product-process matrix."

5.4.5 Region (2,1)

Thirty-three firms were identified as occupying region (2,1), which is the region associated with low volume, multiple variety products using jumbled flow (job shop) manufacturing. Twenty different industries were represented within this region with the top four industries being printing, wood products (except furniture), industrial/commercial machinery, and electrical equipment. Employment sizes ranged from 10 to 24 employees to over 1000 employees with the majority of firms being within the 10 to 24 employees size bracket. Sales volume ranged from under $1 million up to $50 to $100 million. The majority of firms fell in the $1 to $5 million category. Sales volume figures on two firms were unable to be obtained since these figures

for the two firms were not provided by the Virginia Business Directory.

The most cited competitive position in this region was the strong competitive position. One firm provided an "other" competitive position response with the comment that no proprietary products were being manufactured. Flexibility was the most selected manufacturing objective, with quality in second place. Two "other" manufacturing responses were given with the comments that multiple objectives were being pursued. Improve market share was the most selected marketing objective. Two "other" marketing responses were offered with one firm stating multiple objectives were being pursued; the other was repositioning. No R&D was the most selected R&D strategic objective. Response totals for the region were as follows:

Question	Answer	# of Responses
Competitive Position	Dominant	5
	Strong	12
	Favorable (unique)	9
	Tenable (slight)	5
	Weak (unstable)	1
	Other	1
Manufacturing Objective	Dependability	2
	Flexibility	11
	Cost Control	3
	On-time Delivery	5
	Quality	10
	Other	2
Marketing Objective	Establish "Niche"	8
	Improve Share	18
	Improve Margins	4
	Maintain Share	1
	Other	2
R&D Objective	No R&D Performed	14
	Process R&D	5
	Product R&D	8
	Both Types of R&D	6

Similarity factors for the seven data items were .222 for the product-specific case and .234 for the industry-specific case. A factor of .269 was calculated for the four survey questions. It is inferred that firms in this region were more similar with respect to their objectives than their firm attributes.

5.4.6 Region (2,2)

Twenty-three firms were identified as occupying region (2,2), which is the region associated with low volume, multiple variety products using disconnected flow (batch)

manufacturing. Twenty different industries were represented within this region with the top three industries being printing, primary metals, and industrial/commercial machinery. Employment sizes ranged from 10 to 24 employees to over 1000 employees. The majority of firms fell within the 100 to 249 employees bracket. Sales volume ranged from under $1 million to the $50 to $100 million category. The majority of firms fell in the $5 to $20 million category.

Over one-third of the firms in this region felt that they had a tenable (slight) competitive position. Almost as many firms felt that they had a strong competitive position. The most selected strategic objectives were quality for manufacturing and improve market share for marketing. The most selected R&D strategic objective was process R&D, although almost as many firms chose no R&D or product R&D. Region response totals were:

Question	Answer	# of Responses
Competitive Position	Dominant	3
	Strong	8
	Favorable (unique)	3
	Tenable (slight)	9
Manufacturing Objective	Dependability	1
	Flexibility	6
	Cost Control	4
	On-time Delivery	1
	Quality	11
Marketing Objective	Establish Position	1
	Establish "Niche"	3
	Improve Share	14
	Improve Margins	3
	Maintain Share	2
R&D Objective	No R&D Performed	7
	Process R&D	8
	Product R&D	7
	Both Types of R&D	1

Similarity for the seven data items was .255 and .265 for the cases of product-specific and industry-specific factors, respectively. Similarity was .310 for the four survey questions. It is suggested that similarity is higher among objectives than firm attributes.

5.4.7 Region (2,3)

Eight firms were identified as occupying region (1,3), which is associated with low volume, multiple variety products using connected flow (assembly line) manufacturing. Six industries were represented within this region. These industries were furniture and fixtures,

electronic/electrical equipment, plastic products, apparel products, fabricated metal products, and optical products. Employment sizes ranged from 10 to 24 employees to 500 to 999 employees. All employment size categories contained one response with the exception of the categories of 25 to 49 employees and 500 to 999 employees, which had two responses each. Sales volume ranged from under $1 million to $20 to $50 million. The highest number of firms fell in the $1 to $5 million bracket.

Half of the firms believed that they had a strong competitive position. The majority of firms selected quality as their manufacturing objective. Half of the firms selected improve share as their marketing objective and product R&D as their R&D objective. Response totals were as follows:

Question	Answer	# of Responses
Competitive Position	Dominant	2
	Strong	4
	Favorable (unique)	1
	Tenable (slight)	1
Manufacturing Objective	On-time Delivery	3
	Quality	5
Marketing Objective	Establish "Niche"	1
	Improve Share	4
	Improve Margins	2
	Maintain Share	1
R&D Objective	No R&D Performed	2
	Process R&D	1
	Product R&D	4
	Both Types of R&D	1

Seven-data-item similarity factors were .219 for the product specific case and .230 for the industry specific case. The four survey question similarity factory was .304. Again, similarity was higher with respect to objectives than firm characteristics.

5.4.8 Region (2,4)

Four firms were identified as occupying region (2,4), which is the region associated with low volume, multiple variety products using continuous flow manufacturing. Three industries were represented within this region including the industries of printing, chemicals, and plastics. Employment sizes were 50 to 99 employees, 250 to 499 employees, and 500 to 999 employees. Sales volume included the $1 to $5 million, $5 to $20 million, and over $100 million categories.

Strong was the most chosen competitive position. The strategic objectives were quality for manufacturing and improve market share for marketing. The region was split upon the two R&D objectives of no R&D and product R&D as the research and development objective. Response totals for the region were:

Question	Answer	# of Responses
Competitive Position	Dominant	1
	Strong	2
	Tenable (slight)	1
Manufacturing Objective	Dependability	1
	On-time Delivery	1
	Quality	2
Marketing Objective	Improve Share	3
	Maintain Share	1
R&D Objective	No R&D Performed	2
	Product R&D	2

Similarity was calculated to be .238 for both cases of the seven data items and .292 for the four survey questions. It was inferred from the equivalent seven data item similarity factor that no similar products were being manufactured. As with the majority of previously discussed regions, objectives were more similar than firm characteristics.

5.4.9 Region (3,1)

Five firms were identified as occupying region (3,1), the region associated with high volume, few major variety products using jumbled flow (job shop) manufacturing. Each firm represented a different industry with industries representing wood products, printing, food products, rubber products, and paper products. Three firms were in the employment size bracket of 25 to 99 employees. The

remaining two firms were in the 50 to 99 employee and 100 to 249 employee sizes. Sales volume was in the two categories of $1 to $5 million and $5 to $20 million. Three of the firms fell in the $5 to $20 million category.

Three of the five firms identified a dominant competitive position. The most selected strategic objectives were quality for manufacturing, maintain market share for marketing, and either process R&D or both types of R&D for research and development. Response totals for the region were:

Question	Answer	# of Responses
Competitive Position	Dominant	3
	Favorable (unique)	1
	Tenable (slight)	1
Manufacturing Objective	Dependability	1
	On-time Delivery	1
	Quality	2
	Responsiveness	1
Marketing Objective	Establish "Niche"	1
	Improve Share	1
	Maintain Share	3
R&D Objective	Process R&D	2
	Product R&D	1
	Both Types of R&D	2

Similarity factors were equivalent for both cases of the seven data items with a value of .229. The similarity of the four survey questions was .225. These values infer that firm attributes were more similar than firm objectives. Equivalence of the factors associated with the seven data

items implied that firms were not manufacturing similar products.

5.4.10 Region (3,2)

Eight firms were identified as occupying region (3,2), which is associated with high volume, few major variety products using disconnected flow (batch) manufacturing. All eight firms were from different industries including printing, plastics, concrete products, electronic/electrical products, textiles, and food products. Half of the firms were in the employment size bracket of 50 to 99 employees. The remaining firms ranged from 100 to 249 employees to 500 to 999 employees. One firm had an employment size of 10 to 24 employees. Sales volume ranged from under $1 million to the category of $20 to $50 million.

The most selected competitive position was a strong position. The popular strategic objectives were quality for manufacturing, improve market share for marketing, and product R&D for research and development. Response totals of the region were:

Question	Answer	# of Responses
Competitive Position	Dominant	1
	Strong	3
	Favorable (unique)	2
	Tenable (slight)	2
Manufacturing Objective	On-time Delivery	3
	Quality	5
Marketing Objective	Establish "Niche"	1
	Improve Share	7
R&D Objective	No R&D	1
	Process R&D	2
	Product R&D	4
	Both Types of R&D	1

The seven data item similarity factors were .291 for the product-specific case and .296 for the industry-specific case. The four survey question similarity factory was .411. The higher value of the latter similarity factor suggested that firms in this region are more alike with regard to strategic objectives than firm attributes.

5.4.11 Region (3,3)

Eleven firms were identified as occupying region (3,3), which is the region associated with high volume, few major variety products using disconnected flow (batch) manufacturing. Seven different industries were represented including agrichemicals, apparel products, wood products, food products, printing, transportation equipment, and furniture. Firms were distributed through the employment

size brackets of 10 to 24 employees to over 1000 employees. The majority of firms were in the lower three employee size brackets (10 to 24 employees, 25-49 employees, and 50 to 99 employees). Sales volume included the brackets of $1 to $5 million, $20 to $50 million, and $50 to $100 million. A majority of firms were in the $1 to $5 million bracket.

Both dominant and tenable were equally selected as the competitive position. One "other" competitive position response was given with the comment being that multi-markets of varying position were being targeted. The most selected strategic objectives for manufacturing and marketing were quality and improve profit margins, respectively. The R&D objective was a three-way tie with the objectives of no R&D, product R&D, and both types of R&D being chosen. Response totals were as follows:

Question	Answer	# of Responses
Competitive Position	Dominant	3
	Strong	2
	Favorable (unique)	2
	Tenable (slight)	3
	Other	1
Manufacturing Objective	Dependability	1
	Flexibility	1
	Cost Control	4
	Quality	5
Marketing Objective	Establish "Niche"	3
	Improve Share	3
	Improve Margins	4
	Maintain Share	1
R&D Objective	No R&D	3
	Process R&D	2
	Product R&D	3
	Both Types of R&D	3

Similarity was calculated to be .208, .218, and .209 for the seven data items (product-specific), seven data items (industry-specific), and four survey questions, respectively. The relative equivalence of all values, in particular the two values of the seven data items (product-specific) and four survey questions, infers that these firms may be equally similar with respect to both firm attributes and strategic objectives.

5.4.12 Region (3,4)

Six firms were identified as occupying region (3,4), which is the region associated with high volume, few major variety products using continuous manufacturing. Each firm

represented a different industry with those industries being chemical products, transportation equipment, machinery, lime products, adhesives, and paper products. Employment size included 25 to 49 employees, 100 to 249 employees, 500 to 999 employees, and over 1000 employees. Sales volume included the categories of $1 to $5 million, $5 to $20 million, $20 to $50 million, and over $100 million. Half of the firms were in the 100 to 249 employment size category and the $5 to $20 million sales volume category.

The most selected competitive position was the strong competitive position. One firm did not respond to the competitive position question. Half of the firms chose quality as the manufacturing objective. One "other" manufacturing response listed an objective of time compression and time management. The majority of firms identified improve market share as their marketing objective and process R&D as their R&D objective. Response totals for the region were as follows:

Question	Answer	# of Responses
Competitive Position	Dominant	2
	Strong	3
	Other	1
Manufacturing Objective	Dependability	1
	Cost Control	1
	Quality	3
	Other	1
Marketing Objective	Improve Share	4
	Improve Margins	2
R&D Objective	Process R&D	4
	Product R&D	1
	Both Types of R&D	1

The similarity for the seven data items was .248 for the product-specific case and .257 for the industry-specific case. The similarity for the four survey questions was .333. Based on these values, firms appeared more similar in their objectives than with respect to firm attributes.

5.4.13 Region (4,1)

Only one firm was identified as occupying region (4,1), the other "void" region, which is associated with high volume, commodity products using jumbled flow (job shop) manufacturing. This firm represented the printing industry with an employment size between 100 and 249 employees and a sales volume between $5 and $20 million. The firm identified a unique competitive position and the strategic objectives of dependability for manufacturing, maintain

market share for marketing, and process R&D for research and development. No similarity factors could be calculated.

As in the case of the other "void" region - region (1,4), the likelihood of this firm occupying this region is debatable. Convention would suggest that there would be insufficient equipment capacity to satisfy the commodity market. In addition, the cost to produce the product using a jumbled flow process could be exorbitant as a result of high labor cost. It is possible that the firm occupying this region may have improperly identified its market and/or manufacturing process. However, one explanation for why a firm would be identified with this region is that a firm may use a hybrid manufacturing process. While a high-volume manufacturing process may be utilized in the initial processing stages, the firm may focus upon low-volume, specialty manufacturing in the product category's final processing stages. This, therefore, could lead to the identification of the firm with region (4,1). Theory would contend that this is a mislabeling of the firm and thus, could be considered an exception to the process life cycle stages within the "product-process matrix."

5.4.14 Region (4,2)

Four firms were identified as occupying region (4,2), which is associated with high volume, commodity products

using disconnected flow (batch) manufacturing. Firms represented the industries of wood products, printing, food products, and paper products. Three of the four firms had employment sizes between 100 and 249 employees. The remaining firm had an employment size of between 10 and 24 employees. Three of the firms were also in the same sales volume bracket, which was $5 to $20 million. The other firm was in the sales volume category of $0 to $1 million.

Two of the four firms identified a favorable competitive position. The preferred objectives were quality for manufacturing, improve market share for marketing, and no R&D for research and development. Response totals were:

Question	Answer	# of Responses
Competitive Position	Dominant	1
	Favorable (unique)	2
	Tenable (slight)	1
Manufacturing Objective	Dependability	1
	Cost Control	1
	Quality	2
Marketing Objective	Establish "Niche"	1
	Improve Share	2
	Maintain Share	1
R&D Objective	No R&D	2
	Process R&D	1
	Product R&D	1

A similarity factors of .238 was calculated for both cases of the seven data items, and a similarity factor of .167 was calculated for the four survey questions. Since

the seven-data-item similarity factor is greater than the four-question similarity factor, it is inferred that firm attributes are more similar than objectives. The equivalence of the seven-data-item similarity factor implies that firms did not manufacture similar products.

5.4.15 Region (4,3)

Five firms were identified as occupying region (4,3), the region associated with high volume, commodity products using connected flow (assembly line) manufacturing. Industries represented were textiles, transportation equipment, plastic products, stone/cut stone products, and gypsum products. Firm size included the employment size brackets of 10 to 24 employees, 25 to 49 employees, 250 to 499 employees, and over 1000 employees. Sales volume was distributed among the five sales volume categories of under $1 million, $1 to $5 million, $5 to $20 million, $20 to $50 million, and over $100 million.

The majority of firms chose strong as their competitive position. Quality was the preferred objective for manufacturing. Both establish market "niche" and improve market share were the preferred strategic objectives for marketing. Product R&D and both types of R&D were the most selected R&D objectives. Response totals for the region were:

Question	Answer	# of Responses
Competitive Position	Strong	3
	Tenable (slight)	2
Manufacturing Objective	Cost Control	1
	On-time Delivery	1
	Quality	3
Marketing Objective	Establish "Niche"	2
	Improve Share	2
	Improve Margins	1
R&D Objective	No R&D	1
	Product R&D	2
	Both Types of R&D	2

Similarity factors of the seven data items were .171 for the product-specific case and .186 for the industry-specific case. A factor of .275 was calculated for the four survey questions. This shows that firms were more similar with respect to objectives than attributes.

5.4.16 Region (4,4)

Seventeen firms were identified as occupying region (4,4), which is the region associated with high volume, commodity products using continuous manufacturing. Twelve different industries were represented with multiple firms falling within the industries of food products, paper products, printing, and machinery. Employment size included 10 to 24 employees, 50 to 99 employees, 100 to 249 employees, 250 to 499 employees, and over 1000 employees. Sales volume was distributed among the five sales volume

categories of under $1 million, $1 to $5 million, $5 to $20 million, $20 to $50 million, and over $100 million. Eight of the seventeen firms were in the $5 to $20 million sales volume category.

The most selected competitive position was the dominant competitive position. The majority of firms selected quality as their manufacturing objective. One "other" manufacturing response was given with the comment being that multiple manufacturing objectives were being pursued. Almost half of the firms selected improve market share as their marketing objective. Both the answers of product R&D and both types of R&D were selected as the R&D strategic objective. Response totals were as follows:

Question	Answer	# of Responses
Competitive Position	Dominant	6
	Strong	4
	Favorable (unique)	1
	Tenable (slight)	5
	Weak (unstable)	1
Manufacturing Objective	Dependability	1
	Cost Control	4
	On-time Delivery	1
	Quality	10
	Other	1
Marketing Objective	Initial Position	1
	Establish "Niche"	4
	Improve Share	8
	Improve Margins	2
	Maintain Share	2
R&D Objective	No R&D	4
	Process R&D	3
	Product R&D	5
	Both Types of R&D	5

Similarity factors of the seven data items were .216 for the product-specific case and .223 for the industry-specific case. The similarity factor for the four survey questions was .270. Again, as with the previous region, firms were more similar with respect to objectives than firm attributes.

5.4.17 Summary of Competitive Position and Strategic Objectives Over "Product-Process Matrix" Regions

Table 5.3 displays the top competitive positions identified by firms for each region of the "product-process matrix." It is observed that not all regions along the diagonal exert a dominant or strong competitive position. Two regions along the diagonal exhibited the weaker competitive positions of favorable (unique) or tenable (slight). This contradicts "product-process matrix" theory, which suggests that stronger competitive positions should fall along the diagonal.

Table 5.3: Top Competitive Position By "Product-Process Matrix" Region

	Low Volume, One-of-a-Kind	Low Volume, Multi-Variety	High Volume, Few Varieties	High Volume, Commodity
Jumbled Flow	**Favorable**	**Strong**	**Dominant**	**Favorable**
Disconnected Flow	**Favorable**	**Tenable**	**Strong**	**Favorable**
Connected Flow	Strong Tenable Favorable	**Strong**	Dominant Tenable	**Strong**
Continuous Flow	**Strong**	**Strong**	**Strong**	**Dominant**

Another observation was that firms off the diagonal identified stronger competitive positions than those the "product-process matrix" theory would suggest. It is proposed by such theory that firms moving away from the diagonal would utilize a market "niche" objective, thereby maintaining a favorable (unique) competitive position. Survey results showed the off-diagonal regions of (2,1), (2,3), (2,4), (3,2), (3,4), and (4,3) exhibiting a strong competitive position and region (3,1) exhibiting a dominant competitive position. The identification of a dominant position off the diagonal is especially interesting since the dominant position showed that firms off the diagonal believed that they were the standard for their industry. As mentioned previously, "product-process matrix" theory

implies that only firms on the diagonal should exhibit dominant competitive positions.

A third observation was that the firms in regions (1,4) and (4,1), which are the "void" regions, identified the competitive positions of strong and favorable. Extension of "product-process matrix" theory would suggest that a firm occupying these regions should be at a significant competitive disadvantage. This disadvantage would result in "void"-region firms having a slight or weak competitive position, if they did exist. The responses from the two "void" region firms do not support such an assertion.

Table 5.4 presents the top manufacturing strategic objectives for each of the "product-process matrix" regions. It is shown that the overwhelming objective is quality. Fourteen of the sixteen regions had quality listed as the (or one of the) top manufacturing objective. The other two regions both of which were associated with jumbled flow manufacturing exhibited the strategic objectives of dependability and flexibility.

The popularity of quality as a strategic objective for most regions is surprising. The theory given previously in this paper suggested that quality should only be an objective (priority) in the first two columns and rows, representing the earlier stages of both the product life cycle and process life cycle. The results of the survey adduce that quality is emphasized at all points in the

"product-process matrix." One explanation for quality's popularity is that international competition has brought the quality issue into the spotlight. By focusing on quality, international firms (particularly the Japanese) have been able to capture market share. This has prompted domestic firms to assess their quality programs. Quality, therefore, may have become a primary objective for many firms.

Table 5.4: Top Manufacturing Objective By "Product-Process Matrix" Region

	Low Volume, One-of-a-Kind	Low Volume, Multi-Variety	High Volume, Few Varieties	High Volume, Commodity
Jumbled Flow	**Quality**	**Flexibility**	**Quality**	**Dependability**
Disconnected Flow	**Quality**	**Quality**	**Quality**	**Quality**
Connected Flow	Cost Control Flexibility Quality	**Quality**	**Quality**	**Quality**
Continuous Flow	**Quality**	**Quality**	**Quality**	**Quality**

Table 5.5 presents the top marketing strategic objectives within each region of the "product-process matrix." It is shown that the objectives of improve market share, improve profit margins, and maintain market share were the preferred marketing objectives. Improve market share was the overall preferred objective with its being the

primary objective for eleven of the sixteen regions. Analyzing marketing objectives, two tendencies were observed. One, improve market share was the top strategic objective for the second column and row of the matrix. From the standpoint of the product life cycle concept, this tendency is explained by the possibility that firms in the second stage (represented by the second column) desire to obtain a greater share of the market. No theory was available to explain this tendency from the standpoint of the process life cycle. It is possible that, as production volume increases due to better manufacturing, the firm must improve share in order to sell the increased volume.

A second observation was that maintain market share was the objective for the regions in the upper right hand corner of the "product-process matrix." The product life cycle concept may also explain this phenomenon. According to the product life cycle concept, firms later in the product life cycle will desire to hold onto existing market share as market potential becomes exhausted.

Table 5.5: Top Marketing Objective By "Product-Process Matrix" Region

	Low Volume, One-of-a-Kind	Low Volume, Multi-Variety	High Volume, Few Varieties	High Volume, Commodity
Jumbled Flow	**Improve Margins**	**Improve Share**	**Maintain Share**	**Maintain Share**
Disconnected Flow	**Improve Share**	**Improve Share**	**Improve Share**	**Improve Share**
Connected Flow	*	**Improve Share**	**Improve Margins**	**
Continuous Flow	**Improve Margins**	**Improve Share**	**Improve Share**	**Improve Share**

Note: * = [Region (1,3)] Improve Share, Improve Margins, Maintain Share

** = [Region (4,3)] Establish "Niche", Improve Share

Table 5.6 displays the top research and development objective for each of the "product-process matrix" regions. R&D objectives were dispersed across all regions with certain regions exhibiting multiple primary R&D objectives. One interesting observation was that no R&D was a strategic objective for two regions in the first column of the matrix. This is contrary to theory, which suggests that product R&D should be pursued in first column regions. Beyond this observation, it was difficult to determine any other tendencies.

Table 5.6: Top R&D Objective By "Product-Process Matrix" Region

	Low Volume, One-of-a-Kind	Low Volume, Multi-Variety	High Volume, Few Varieties	High Volume, Commodity
Jumbled Flow	**No R&D**	**No R&D**	Process R&D Both Types	**Process R&D**
Disconnected Flow	**Product R&D**	**Process R&D**	**Product R&D**	**No R&D**
Connected Flow	**No R&D**	**Product R&D**	No R&D Product R&D Both Type	Product R&D Both Types
Continuous Flow	**Process R&D**	No R&D Product R&D	**Process R&D**	Product R&D Both Types

5.4.18 Summary of Similarity Factors Over "Product-Process Matrix" Regions

Table 5.7 displays the similarity factors for the two cases of the seven data items -- product-specific and industry-specific. There appears to be no major difference between "product-process matrix" regions when comparing either the product-specific similarity factors or industry-specific similarity factors. Calculated values remained relatively constant between regions. In the first two columns of the matrix, similarity factors decreased farther away from the diagonal region. In columns three and four, this tendency did not arise. No tendencies were observed from a row standpoint. Region (1,1) exhibited the highest similarity value. Perhaps firm attributes become dissimilar

as products achieve higher volume and greater standardization. This suggests that firm attributes may become dissimilar in the later stages of the product life cycle.

Table 5.7: Similarity Factors For The Seven Data Items By "Product-Process Matrix" Region

	Low Volume, One-of-a-Kind	Low Volume, Multi-Variety	High Volume, Few Varieties	High Volume, Commodity
Jumbled	.405	.222	.229	n.a.
Flow	.429	.234	.229	
Disconnected	.343	.255	.291	.238
Flow	.343	.265	.296	.238
Connected	.190	.219	.208	.171
Flow	.190	.230	.218	.186
Continuous	n.a.	.238	.248	.216
Flow		.238	.257	.223

Note: The top number is the product-specific similarity factor. The bottom number is the industry-specific similarity factor.

Table 5.8 displays the similarity factors for the four survey questions for each "product-process matrix" region. As with the similarity factor for the seven data items, columns one and two showed a tendency of factors to decrease as they moved farther away from the diagonal. Columns three and four did not reflect this tendency. The region showing the highest four-question similarity factor was region (3,2).

Table 5.8: Similarity Factors For The Four Survey Questions By "Product-Process Matrix" Region

	Low Volume, One-of-a-Kind	Low Volume, Multi-Variety	High Volume, Few Varieties	High Volume, Commodity
Jumbled Flow	.333	.269	.225	n.a.
Disconnected Flow	.275	.310	.411	.167
Connected Flow	.250	.304	.209	.275
Continuous Flow	n.a.	.292	.333	.270

5.5 Transition of Strategic Objectives Over The Product Life Cycle

With each column representing a different stage in the product life cycle, tallying responses by column allows the top strategic objectives for each product life cycle stage to be determined. The comparison of these objectives might show a transition of objectives over the product life cycle. In stage one -- low volume, one-of-a-kind products -- the top objectives for manufacturing, marketing, and research and development were quality, improve share, and no R&D, respectively. In stage two -- low volume, multiple variety products -- the top objectives did not change from the first stage. In stage three -- high volume, few major variety

products -- quality and improve market share were still the top objectives for manufacturing and marketing, but the research and development objective became process R&D. In stage four, product R&D became the research and development priority. The objectives for manufacturing and marketing were still quality and improve market share. These objectives are presented in Table 5.9 below.

Table 5.9: Top Strategic Objectives Over The Product Life Cycle

	Low Volume, One-of-a-Kind	Low Volume, Multi-Variety	High Volume, Few Varieties	High Volume, Commodity
Manufacturing Objective	**Quality**	**Quality**	**Quality**	**Quality**
Marketing Objective	**Improve Mkt. Share**	**Improve Mkt. Share**	**Improve Mkt. Share**	**Improve Mkt. Share**
R&D Objective	**No R&D**	**No R&D**	**Process R&D**	**Product R&D**

The results shown in Table 5.9 are contrary to theory presented in the literature review. In fact, opposite to the theory. Hayes and Wheelwright [1984], Hax and Majluf [1984], and others have suggested that priorities change

over stages of the product life cycle. Survey response totals showed that quality and improve market share were maintained as objectives between columns. This infers that these objectives may be maintained through the product life cycle. With respect to R&D objectives, Fox [1973], Hofer [1975], Anderson and Zeithaml [1984], and Canada and Sullivan [1989] have contended that R&D objectives will change over time starting with product R&D in stage one. Survey results showed a major number of firms in the first two columns identifying the objective of no R&D. The high number of firms with small employee sizes associated with these two columns may have influenced this objective, since it is assumed that smaller firms have limited resources to undertake R&D activities. In the third column (representing stage three of the product life cycle), the R&D objective matched the suggested R&D objective of process R&D. In the fourth column (representing stage four of the product life cycle), theory stated that a process R&D or no R&D strategic objective should be pursued. Survey results showed that firms in this column are pursuing a product R&D objective.

5.6 Transition of Strategic Objectives Over The Process Life Cycle

Tallying the responses for each "product-process matrix" row suggested the top strategic objectives for each

process life cycle stage. In the first stage -- jumbled flow (job shop), the manufacturing, marketing, and research and development objectives were quality, improve share, and no R&D, respectively. In the second stage -- disconnected flow (batch flow), the objectives of manufacturing and marketing remained the same, but the research and development objective changed to product R&D. In the third stage -- connected flow (assembly line), there was no deviation from objectives in the second stage. In the fourth stage -- continuous flow, the research and development objective was a three-way tie among the three options of process R&D, product R&D, and both types of R&D. Manufacturing and marketing objectives did not change. Table 5.10 summarizes these objectives across the process life cycle.

Table 5.10: Top Strategic Objectives Over The Process Life Cycle

	Jumbled Flow	Disconnected Flow	Connected Flow	Continuous Flow
Manufacturing Objective	**Quality**	**Quality**	**Quality**	**Quality**
Marketing Objective	**Improve Mkt. Share**	**Improve Mkt. Share**	**Improve Mkt. Share**	**Improve Mkt. Share**
R&D Objective	**No R&D**	**Product R&D**	**No R&D or Product R&D**	**Product R&D or Process R&D**

The only existing theory regarding the process life cycle concerns the strategic objectives of manufacturing [Abernathy and Townsend, 1975; Hayes and Wheelwright, 1984]. This theory suggests that the manufacturing objective will change from flexibility and quality to dependability and cost. Survey results showed that quality remained as the strategic objective across "product-process matrix" rows, which depict process life cycle stages. For marketing, it was exhibited that improve market share remained as an objective between the rows of the matrix. The survey showed R&D objectives following the transition of no R&D to product R&D to no R&D/product R&D to product R&D/process R&D. The

transition between "product-process matrix" rows follows the transition suggested by literature for the process life cycle. An exception between the transition exhibited by survey results and literature-suggested transition is that the objective of no R&D should not be pursued early, as was shown with the survey results transition. Again, the smaller size of firms in row one may have influenced the selection of the no R&D objective. It is assumed that smaller firms might have difficulty in maintaining in-house R&D activities due to limited resources.

5.7 Similarity of Survey Findings To Theory

Evaluation of the similarity between the findings of the survey and the hypothesized objectives from the literature review was performed by first determining the appropriate set of hypothesized marketing objectives. This was accomplished by using the top competitive position per region and selecting the strategic objective suggested by Table 2.3. The strategic objectives for manufacturing and R&D were those strategic objectives listed in Appendix A.

The hypothesized strategic objectives were compared to the top strategic objectives of each region. An overall similarity factor of .31 was calculated. Table 5.11, which displays the similarities per region, shows five regions not matching any objectives and one region matching the

prescribed objectives. Table 5.11 also shows that the majority of the no-match regions were in the fourth column, which represents the fourth stage of the product life cycle. This leads to the suggestion that hypothesized objectives may be more applicable to earlier life cycle stages than later life cycles stages. This suggestion is supported by column three and rows three and four, which show that there is reduced or no similarity between hypothesized objectives and the objectives identified by survey results.

Table 5.11: Similarity Factor Per "Product-Process Matrix" Region Based on Survey Findings and Hypothesized Objectives

	Low Volume, One-of-a-Kind	Low Volume, Multi-Variety	High Volume, Few Varieties	High Volume, Commodity
Jumbled Flow	.33	.33	1.0	0
Disconnected Flow	.67	.33	.33	.67
Connected Flow	.33	.33	0	0
Continuous Flow	0	.33	.33	0

5.7.1 Summary of Survey Results

A summary of survey results shows that the median Virginia manufacturing firm had between 100 and 249

employees and a sales volume of between $1 and $5 million. The median competitive position was a strong competitive position with the median strategic objectives being quality for manufacturing, improve market share for marketing, and no R&D or product R&D for research and development.

Survey results did not support what is suggested by literature, which was that objectives should change between "product-process matrix" regions. Instead, results showed the opposite to be true with the objectives of marketing and manufacturing remaining fairly constant between regions. Only the objectives of research and development reflected a high degree of change between regions.

Chapter 6

Conclusions and Summary

6.1 Conclusions

This research centered around four research objectives. The first objective was to determine appropriate strategic objectives for the three functions of manufacturing, marketing, and research and development. By determining these strategic objectives, a list of strategic objectives was constructed to show categories that firms believe exist when determining actual strategies. Survey findings indicated that the given strategic objectives for manufacturing, marketing, and R&D were appropriate. Only two new strategic objectives were identified. These were the objectives of "time compression/time management" for manufacturing and "repositioning" for marketing. In determining these strategic objectives, an important assumption was that the general manager would understand the survey, not be biased by the suggested objectives, and be able to identify the strategic objectives being pursued at his or her facility.

The second research objective was to identify the feasible regions within the "product-process matrix." Prior to this research, no work had been identified showing empirically the validity of regions within the "product-process matrix." The findings of this research suggest that firms may exist in all "product-process matrix" regions (at least they believe that they do). Theory offered the view that certain regions would remain unoccupied. This research did show that the regions supposed to be unoccupied (termed "void") were unpopular among survey respondents. It is also possible that firms occupying the "void" regions may have improperly selected their product structure and/or manufacturing process.

The third research objective was to determine the strategic characteristics associated with particular "product-process matrix" regions. Specific attention was paid to the strategic objectives for each region. The determination of characteristics and objectives by region provided insight into the influence of manufacturing process and product (market) category upon these characteristics. This research found that certain strategic objectives do not often change when switching regions, specifically the strategic objectives of manufacturing and marketing. It was found that the strategic objectives of quality for manufacturing and improve market share for marketing remained relatively constant across regions.

The fourth research objective was to assess the transition of strategic objectives to ascertain if transition actually occurs. In addition, strategic objectives were compared to a hypothesized set of strategic objectives to determine if hypothesized objectives are applicable. This research could not validate the hypothesized strategic objectives. Instead, it was found that similarity between the hypothesized objectives and empirical objectives were different with certain regions displaying no similarity at all. It was concluded that this suggests that an alternative objectives set may exist. An assumption used in this research was that the objectives of the firm would be reflected in a firm's manufacturing facility. It is admitted that hypothesized objectives may not apply to individual manufacturing facilities, but instead to the objectives being pursued at a firm's headquarters.

In addition to these objectives, this research also made possible several observations. One was that firms along the diagonal do not necessarily hold a strong or dominant competitive position, contradicting what "product-process matrix" theory would suggest. Akin to this, it was observed that firms off the diagonal do not always follow a "niche " objective. This, too, contradicted "product-process matrix" theory. A third observation was that region (2,1), which was associated with low volume, multiple

variety products using jumbled flow manufacturing, was the region with the most responses. This contradicted "product-process matrix" theory, which would suggest that the majority of firms should fall along the diagonal of the matrix since that is where industry norms are supposed to reside. One rationale, however, for the popularity of this region could be that firms using a jumbled flow process do not ordinarily operate in a one-of-a-kind market. It is more realistic to believe that such firms would operate in a low volume, multiple variety market. It is therefore offered that column descriptions given by Hayes and Wheelwright may not be appropriate.

6.2 Comments Regarding Survey Findings

The results of this research do not support the theory suggested by literature. It is conceded, though, that problems of bias may have caused such findings. In particular, the three biases associated with the survey instrument, survey sample, and environment could have influenced results. There is also the possibility that the theory itself may be flawed.

Reasons for possible bias in the survey instrument include stating strategic objectives on the survey, using broad descriptions, and using a check-the-answer survey format. By providing survey respondents with a list of

strategic objectives, survey responses may have been influenced. It is possible that the survey respondent opted to select a listed objective even though alternative strategic objectives were being pursued. The descriptions of the stated response may have inappropriately described market, process, competitive position, and/or strategic objectives. This could have confused respondents. Unclear descriptions could have been too broad leading to inaccurate responses. Many firms utilize hybrid manufacturing processes, multiple markets, and multiple objectives. The check-the-answer format also could have contributed to bias as a result of user's not choosing responses which accurately described their manufacturing facility. Respondents could have checked the wrong item, also.

Survey sample bias can be attributed to such areas as no-response bias, the surveying of manufacturing facilities instead of headquarters, the respondent being the general manager, and the use of exclusively Virginia firms. No-response bias may have existed since all firms did not respond to the survey. This permits questions to arise regarding the appropriateness of the response group. The surveying of manufacturing facilities only also may have contributed bias since questions may be raised concerning the appropriateness of strategic objective responses. It is conceivable that had a survey of corporate headquarters been undertaken, different strategic objectives may have been

identified. The use of the general manager as the survey respondent may have contributed bias since he or she may not have been in the position to make unbiased selections. The use of Virginia firms was also a potential source of bias because it is possible that Virginia products, processes, and objectives may not be generalizable to all domestic firms.

Another source of bias may have been environmental bias. Responses, particularly objectives, could have been selected on the basis of popularity. For example, "quality" has become a prevalent "buzz" word in manufacturing. It is possible that firms selected this objective because of its appeal rather than because they actually pursued this objective. Another aspect of environmental bias may have been that firms responded in such a way as to put themselves in a more favorable position; that is, firms may have selected responses that would make them seem better companies (e.g. selection of stronger competitive positions, "buzz" word strategic objectives).

With possible biases existing, it is difficult to determine faults in the theory given by literature. However, survey results contradict what theory suggests; therefore, the presence of errors in the theory is also a possibility. Future research must be directed at minimizing biases associated with the survey instrument, survey sample, and the environment. Undertaking such research will then

allow for an improved assessment of existing theory so that errors in the theory can be detected and corrected.

6.3 Research Summary and Recommendations For Further Research

This research proposed to investigate the transition of strategies over product and process life cycles. To perform this study, the "product-process matrix," a concept suggested by Hayes and Wheelwright [1979a, 1979b, 1984], was used as a foundation for structuring a survey and examining survey results. Once constructed, the survey was sent to Virginia manufacturers to assess their strategic objectives for the three operating functions of manufacturing, marketing, and research and development. Following receipt of completed surveys, an analysis to determine similarities among firms within the same "product-process matrix" region was undertaken.

A goal of this research was to identify strategic objectives and to show whether or not objectives change between columns and rows of the "product-process matrix," which represented the stages of both the product life cycle and process life cycle. Another goal was to define better the "product-process matrix" both in terms of strategic concerns and feasible (and infeasible) regions. Although conclusions were made, the reduced size of the survey sample

warrants further research in order to remedy validity problems exisiting in this research. First, however, research must be undertaken to minimize bias associated with the survey instrument, survey sample, and environment. Once this research has been undertaken, related research can be performed to analyze the conclusions suggested within this thesis. In addition, the VAMFGS database can be updated to contain corrected data in order that associated research could be pursued. Topics might include an analysis into the influence of competitive position upon strategic objectives and the dispersion of SIC codes within the "product-process matrix" to determine if particular industries are inherent to specific regions. Other future research endeavors might also include an assessment of foreign-owned firms to determine if strategic characteristics over product and process life cycles differ between domestic and foreign-owned firms. Additionally, research might also include an analysis of the remaining operation functions of accounting and finance.

What this research has done is to accomplish an initial step in analyzing the "product-process matrix" and the transition of strategic objectives. Although there are potential biases in this research, the possibility that the theory suggested by literature is flawed does exist and should be further investigated. Work must first focus on minimizing biases existing in this research. This includes

improving the survey instrument and survey procedures. Then, it will be possible to perform a comprehensive analysis of existing theory to detect flaws, if they do exist. With this research being the first of its kind, a door to new research opportunities has been opened. It is hoped that researchers take notice of these opportunities and begin to chart this previously unresearched area.

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Appendix A

Hypothesized Strategic Objectives Over Product and Process Life Cycles

Hypothesized Strategic Objectives As Found By The Literature Review

	LOW VOLUME, ONE-OF-A-KIND	LOW VOLUME, MULTIPLE VARIETY	HIGH VOLUME, FEW VARIETIES	HIGH VOLUME, COMMODITY
JUMBLED FLOW	MFG: -Flexibility -Quality -Customization MKT: -Establish initial market position R&D: -Product R&D	MFG: -Flexibility -Quality -Customization MKT: -Mkt share growth -Mkt share maintenance -"Niche" -Cash flow maximization R&D: -Product R&D -Process R&D	MFG: -Flexibility -Quality -Customization MKT: -Mkt share growth -Mkt share maintenance -"Niche" -Cash flow maximization R&D: -Process R&D	MFG: -Flexibility -Quality -Customization MKT: -Mkt share maintenance -Cash flow maximization -Harvesting -Abandon R&D: -No R&D
DISCONNECTED FLOW	MFG: -Flexibility -Quality -Customization MKT: -Establish initial market position R&D: -Product R&D	MFG: -Flexibility -Quality -Customization MKT: -Mkt share growth -Mkt share maintenance -"Niche" -Cash flow maximization R&D: -Product R&D -Process R&D	MFG: -Flexibility -Quality -Customization MKT: -Mkt share growth -Mkt share maintenance -"Niche" -Cash flow maximization R&D: -Process R&D	MFG: -Flexibility -Quality -Customization MKT: -Mkt share maintenance -Cash flow maximization -Harvesting -Abandon R&D: -No R&D
CONNECTED FLOW	MFG: -Dependability -Cost MKT: -Establish initial market position R&D: -Product R&D	MFG: -Dependability -Cost MKT: -Mkt share growth -Mkt share maintenance -"Niche" -Cash flow maximization R&D: -Product R&D -Process R&D	MFG: -Dependability -Cost MKT: -Mkt share growth -Mkt share maintenance -"Niche" -Cash flow maximization R&D: -Process R&D	MFG: -Dependability -Cost MKT: -Mkt share maintenance -Cash flow maximization -Harvesting -Abandon R&D: -No R&D
CONTINUOUS FLOW	MFG: -Dependability -Cost MKT: -Establish initial market position R&D: -Product R&D	MFG: -Dependability -Cost MKT: -Mkt share growth -Mkt share maintenance -"Niche" -Cash flow maximization R&D: -Product R&D -Process R&D	MFG: -Dependability -Cost MKT: -Mkt share growth -Mkt share maintenance -"Niche" -Cash flow maximization R&D: -Process R&D	MFG: -Dependability -Cost MKT: -Mkt share maintenance -Cash flow maximization -Harvesting -Abandon R&D: -No R&D

Note: Marketing strategies vary according to competitive position.

Appendix B

Calculation of the Jaccard Similarity Coefficient

CALCULATION OF THE JACCARD SIMILARITY COEFFICIENT

Assume Firms A, X, and Y occupy one "product-process" matrix region. Firms have the following attributes:

	Firm A	Firm X	Firm Y
Employment Size Code	D	E	D
Sales Volume Code	C	C	B
SIC Code	2491	3568	3599
Competitive Position +	1	2	2
Manufacturing Objective ++	5	2	5
Marketing Objective +++	3	5	4
R&D Objective ++++	4	4	4

+ Competitive Positions were coded as follows: Dominant - 1, Strong - 2, Favorable - 3, Tenable - 4, Weak - 5, Other - 6.

++ Manufacturing Objectives were coded as follows: Dependability - 1, Flexibility - 2, Manufacturing Cost Control - 3, On-time Delivery - 4, Quality - 5, Responsiveness - 6, Other - 7.

+++ Marketing Objectives were coded as follows: Establish Initial Market Position - 1, Establish Market "Niche" - 2, Improve Market Share - 3, Improve Profit Margins - 4, Maintain Market Share - 5, Other -6.

++++ R&D Objectives were coded as follows: No R&D Activities - 1, Process R&D - 2, Product R&D - 3, Both R&D Activities - 4.

Similarity Factors Are Calculated Between Firms X and Y:

Category	Match	Product-Specific Score	Industry-Specific Score
Employment Size Code	No	0	0
Sales Volume Code	No	0	0
SIC Code	No/Yes*	0	1
Competitive Position	Yes	1	1
Manufacturing Objective	No	0	0
Marketing Objective	No	0	0
R&D Objective	Yes	1	1
	Total	2	3

* The firms do not have the exact SIC codes (product-specific case), but firms do have the identical first two numbers in their SIC code (industry-specific case).

Seven Data Item Similarity Factor:

Product-Specific Case = # Matches/Total Possible Matches

= 2/7 = .286

Industry-Specific Case = # Matches/Total Possible Matches

= 3/7 = .428

Four Survey Question Similarity Factor:

Matches/Total Possible Matches = 2/4 = .500

Similarity Factors Between Firms A, X, and Y were calculated and are presented in the tableaus below. From these tableaus region similarity factors are calculated.

Product-Specific Similarity Factor

	A	X	Y
A	-	-	-
X	.286	-	-
Y	.428	.286	-

Industry-Specific Similarity Factor

	A	X	Y
A	-	-	-
X	.286	-	-
Y	.428	.428	-

Four Survey Question Similarity Factor

	A	X	Y
A	-	-	-
X	.250	-	-
Y	.500	.500	-

Region Similarity Factors are calculated by averaging values for each of the three similarity factors.

Product-Specific Similarity Factor = (.286 + .428 + .286)/3

= .333

Industry-Specific Similarity Factor = (.286 + .428 + .428)/3

= .381

Four Question Similarity Factor = (.250 + .500 + .500)/3

= .417

Appendix C

Cover Letter and Survey

COLLEGE OF ENGINEERING

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061

DEPARTMENT OF INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH (703) 961-6656

February 22, 1989

Dear Sir or Madam:

We are involved in researching the area of strategy for manufacturing firms in Virginia. A primary point of interest is to learn how the manufacturing process and the market influence the strategic objectives of a firm, especially those objectives for manufacturing, marketing, and research and development. To assist in this research, we have constructed the enclosed one-page survey.

We would appreciate your responses to this survey. As you can see, the survey has been designed so that it can be filled out as a checklist in most cases. Any additional information that you feel may be of interest would also be appreciated. Note that it is not necessary to identify your firm. The code located in the right hand corner of this survey serves to identify your company. All your individual responses will remain strictly confidential. Only aggregated responses will be analyzed or reported. Completed forms should be returned to us at the above address. For your convenience, we have enclosed a self-addressed, stamped envelope.

A date of March 24, 1989 has been set as a deadline for survey responses in order that analysis can be completed by April 31, 1989. If desired, a copy of our findings can be sent to you upon completion of our analysis. To receive a copy of our findings, include your name and address with the survey.

Thank you for your time and cooperation.

Sincerely,

H. J. Freeman, Ph.D., P.E.
Assistant Professor

Kenneth B. Kahn
Graduate Student

HJF/jjc
Enclosure

COMPANY STRATEGIC OBJECTIVES SURVEY

Instructions: Check the answer that best describes the situation at your firm. Only one check per question, please. A section is provided at the end of this survey for any comments or additional information which you may wish to give. If desired, you can attach a separate sheet of comments or information. We appreciate your time and help on this.

Q1: What best describes your primary product category? [Check only one, please.]

____ Low volume, low standardization, one-of-a-kind
____ Multiple varieties, low volume
____ Few major varieties, high volume
____ High volume, high standardization, commodity
____ Other (Please Specify) _____

Q2: What best describes your market position in this primary product category? [Check only one, please.]

____ Standard for the market: dominant position.
____ Product's position has a definite edge over competitors, but it is not dominant.
____ Product is unique within the market due to a market niche or market differentiation.
____ Slight difficulty in gaining and/or retaining market share although product is in a fairly stable position.
____ Unstable product position which may not be sustained in the long run.
____ Other (Please Specify) _____

Q3: What best describes your manufacturing process(es)? [Check only one, please.]

____ JOB SHOP - focus on work centers. Equipment and labor force has flexibility in manufacturing different products.
____ BATCH FLOW - production follows a loose standard flow pattern. Equipment and labor specialized in certain tasks.
____ ASSEMBLY LINE - equipment and labor are dedicated to particular tasks. Tasks are synchronized to produce the overall product(s). Production follows a definite flow pattern.
____ CONTINUOUS FLOW - production dedicated to a primary product using highly mechanized, standardized, and/or automated process. Labor and equipment highly specialized and dedicated to specific tasks.
____ Other (Please Specify) _____

Q4: What is the primary objective of your manufacturing operations? [Check only one, please.]

____ DEPENDABILITY - focus on remaining operational by minimizing downtime.
____ FLEXIBILITY - focus on satisfying a diverse product line.
____ MANUFACTURING COST CONTROL - maintain control over manufacturing costs.
____ ON-TIME DELIVERY - focus on meeting due dates.
____ QUALITY - focus on producing a quality product efficiently.
____ RESPONSIVENESS - focus on producing a new product in minimal time.
____ Other (Please Specify) _____

Q5: What is the primary objective of your marketing activities? [Check only one, please.]

____ ESTABLISH INITIAL MARKET POSITION - establish market for new product forms or brands.
____ ESTABLISH MARKET "NICHE" - focus on a small segment of the market which has unique needs.
____ IMPROVE MARKET SHARE - increase current market share.
____ IMPROVE PROFIT MARGINS - increase current profit margins.
____ MAINTAIN MARKET SHARE - hold current market position.
____ Other (Please Specify) _____

Q6: What is the primary objective of your research and development (R&D) activities? [Check only one, please]

____ NO R&D ACTIVITIES
____ PROCESS R&D - activities focused upon process improvement and new process techniques/technologies.
____ PRODUCT R&D - activities focused upon product improvements including new product designs and materials.
____ BOTH R&D ACTIVITIES - equal emphasis on both types of R&D.
____ Other (Please Specify) _____

Please add your comments on the back of this survey.

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