THE DYNAMICS OF COMPETITIVE STRATEGY

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ABSTRACT

Since its inception, the field of strategy has been seeking answers to the question of why some firms succeed while others fail. Porter's positioning theory addresses the problem of understanding the causes of superior performance at a given period in time (termed the cross-sectional problem). However, positioning theory does not address the dynamic processes by which competitive positions are created (termed the longitudinal problem). In the last few years, the search for tools and techniques to understand and manage dynamic complexity has moved to the forefront of research on strategy.

This thesis proposes integrating the current state of knowledge, tools, and techniques from the discipline of system dynamics with Porter's positioning theory and the resource-based view to overcome the deficiencies identified in the field of strategy. Not only does system dynamics provide the necessary tools to understand and manage dynamic problems in strategy, but the tools also offer the language to integrate knowledge from the relatively static positioning theory (with activities as the core determinant of advantage) and resource-based view (with resources as the core determinant of advantage) in a common framework. The outline of a framework for integrating the best thinking from multiple disciplines is sketched. An example of resource accumulation is used to demonstrate the utility of system dynamics modeling in integrating a discussion of the importance of assets, activities, and managerial choices in strategy.

Finally, the thesis presents the design of a model that is being developed as an experimentation field for the integrated theory of strategy. The model is being developed to codify the patterns of commitment to activities and resource accumulation that characterizes superior performance, and just as importantly, to search for the causes of corporate problems that are observed frequently in firms.

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To my parents

Eunice and David

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I dedicate this thesis to my parents.

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Introduction

Why do some firms succeed while others fail? This question is intimately related to questions like: Why do firms differ? What are the conditions for success? What is it about the firm or its environment that promotes or precludes success? Since its inception, the field of strategic management has been seeking answers to these questions. Scores of theories have been proposed, used to guide the practice of strategic management, and then replaced or supplemented by newer theories. The previous decade has been no different.

To operationalize the conceptual frameworks that have been proposed in the literature on strategy and to use the insights emerging from empirical studies of firms, managers often try to reconcile the ideas suggested by different frameworks. Managers need to know what the important variables are so they can focus their attention on them. But we need to go beyond asking the right questions. Even if management attention is focused in the right direction, it does not follow that decision makers will find the right answers. Managers need to know how to intervene with the business systems that they are a part of. They need to know where their interventions will have the most impact, whether to push or pull these high-impact levers, what the extent of their interventions should be, and how to time these interventions. Achieving this level of understanding requires sophisticated analytical tools and techniques that enhance the decision maker's ability to comprehend the complexity of

business systems. Preparing these tools and techniques remains a challenge in strategic management. This thesis proposes a framework for how some promising new methodologies can be reconciled and used together to enrich the practice of strategic management.

The literature on strategy is littered with frameworks claiming to prescribe *the* success formula for companies. Terms like competitive advantage, core competencies, resource leverage, value creation, and strategic intent represent some of the most creative ideas in strategy. Terms like reinforcing loops, growth drivers, leverage points, and feedback which were the domain of other disciplines have filtered into the discussion on strategy today. But what do they all mean? How does one choose between the varied success formulas these ideas promise? At what point do we distinguish between the operational realities of competition and the frameworks that serve as abstractions to help us understand and explain reality? Frameworks try to focus management attention on the important variables, but different frameworks focus on different variables. It is easy to get lost in a world of conflicting frameworks that focus management attention on different aspects of competition. Indeed, just keeping up with the nomenclature is a confounding task in itself.

What is required, then, is a truly *fundamental* look at the business of firms and an *operational* understanding of the factors responsible for superior performance. We should not mistake the world for the frameworks we use to understand it. Our frameworks are often limited to being static and two-dimensional; the world isn't. In the search of answers to the questions we posed at the beginning, this thesis takes a fundamental look at business and provides a framework for developing an operational understanding of why some firms are better able to achieve superior performance. The limitations of individual frameworks in strategy can be overcome by integrating the strengths of research done in positioning theory, the resource-based view of the firm, and system dynamics. Other promising streams of research, like game theory and commitment theory, are also discussed.

BACKGROUND AND MOTIVATION

In 1994, in pursuit of the secrets of superior business performance, I embarked on a study of *generic management structures.* These structures are stylized models that represent hypotheses about the structural determinants of commonly observed behaviors in firms.[1] The behavior resulting from the structures could be studied by performing computer simulations of these models. My intention was to catalog the most popular structures in the literature, develop a framework that would identify areas where new models were needed, and possibly build one or two of these models myself. Then I realized that my intentions were not only on the foolish side of brave, but that I was also working on the wrong problem. The handful of structures that can reasonably be considered generic had been built by accomplished scholars over the past four decades—far longer than the time I wanted to spend on my thesis. More important, I was approaching the problem from the wrong perspective. I was thinking only of those problems in strategy that had already been studied using system dynamics and was missing the diversity of issues that populate the problems of strategic management.

Realization did not come easy. I was investing heavily in the science of system dynamics[2] and, like a child with a new hammer, I was on the look-out for nails. At about the same time, I was reading Utterback's *Mastering the Dynamics of Innovation,*[3] Hamel and Prahalad's *Competing for the Future,*[4] and Edith Penrose's *The Theory of the Firm.*[5] The strong emphasis these books placed on the actions of the firm complemented my earlier readings on the role of the environment in Porter's *Competitive Strategy.*[6] Penrose's inside-out approach studying the effects of a firm's

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[1] See Graham (1990) for an example of one codification of generic management structures.

[2] The discipline of system dynamics was pioneered by Jay Forrester at the MIT Sloan School of Management in the early 1960s.

[3] See Utterback (1994)

[4] See Hamel and Prahalad (1995)

[5] See Penrose (1969)

[6] See Porter (1880)

actions on the environment meshed well with Porter's outside-in approach studying the effect of the environment on the performance of a firm. And all along Forrester had been stressing the need for understanding the *mutual* interactions between the firm and its environment.[7] There were obvious synergies to be had by integrating the various streams of research.

From my readings in strategy, I noticed that some of the most influential work in the field had aimed at distilling *generic principles* from the case-studies of many firms across several industries. The insights into firm behavior came from 'data' in the well-developed, but implicit, mental models of the authors. It is exciting to recognize that the insights learned from a few days of simulating models of generic management structures were comparable to the insights that had been developed by years of empirical study. Furthermore, the process of making explicit these mental models by building structures gives us the ability to create insights ourselves rather than depend on the gurus of strategy to feed us their insights. However, to find the reasons behind superior performance, it would not be enough to build a few generic structures and depend on senior managers to find and use them correctly. To inform the practioners of strategic management requires viewing the world from their perspective. A sensible approach to developing better frameworks, tools, and techniques would begin by using the established, traditional frameworks as a starting point and then move from these towards other disciplines to see what they had to offer.

I thus embarked on this thesis with resolve to find the linkages between traditional strategy and system dynamics. A second reading of Porter's books on *Competitive Strategy* and *Competitive Advantage* gave me the assurance that they represented some of the best work in the field of strategy, but left me with the uneasiness that only half of the problem had been worked on. Although the causes of superior performance at a point in time had been well studied through positioning theory, there was little understanding of the dynamic processes by which superior positions are created and sustained over time. System dynamics, with its emphasis on

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[7] See Forrester (1961)

the dimension of time, seemed capable of providing the rest of the picture. The resource-based view of the firm, game theory, and the relatively new commitment theory also promised important contributions to a dynamic theory of the firm.

The pieces were all there, but they needed to be connected in a coherent whole. I decided to use Porter's work on positioning to anchor the scope of this thesis on the static end of the spectrum while using system dynamics to provide perspective on the dynamic side of things. I sensed that to be able to answer why some firms succeed while others fail, in addition to making sense of the pieces, I would also need to understand the connections between them. The static aspects of strategy need to be integrated with the developing dynamic theory to provide the framework for an *integrative* theory of strategy. The integrated theory, as proposed here, is a composite of research on static problems (drawing from Porter's positioning theory) and research on dynamic problems (primarily from system dynamics, but with contributions from the resource-based theory). Game theory and commitment theory also provide answers to certain types of static and dynamic problems.

The purpose of this thesis, then, is to translate between the language of strategy and the language of system dynamics. We take a dialectic approach by continually questioning the reasons for superior performance and use logical reasoning to trace backward through the chain of causality in search for the true origins of competitive advantage. The thesis provides a theoretical basis for integrated research on static and dynamic problems in strategic management.

SUMMARY OF CHAPTERS

The next chapter explores the issues in developing a dynamic theory of strategy through a discussion of the major challenges that such a theory must face. We present seven criteria to serve as benchmarks to measure quality of a dynamic theory. Some promising candidates for a new theory to explain dynamics—game theory, commitment theory, and resource-based theory—are assessed by measuring them against specified criteria.

Next, we use Porter's approach to decompose the theory of strategy into a cross-sectional problem and a longitudinal problem to identify deficiencies in the existing knowledge about strategy. The cross-sectional problem seeks to find the causes behind a firm's superior performance at a point in time. The longitudinal problem studies the dynamic processes over time through which firms achieve superior positions. Both the problems are discussed at length and their relation to each other is mapped. The discussion on the cross-sectional problem relies on an understanding of positioning theory.

We propose integrating the current state of knowledge, tools, and techniques from the discipline of system dynamics with Porter's positioning theory and the resource-based view to overcome the deficiencies identified in the field of strategy. Not only does system dynamics provide the necessary tools to understand and manage dynamic problems in strategy, but the tools also offer the *language* to integrate knowledge from the relatively static positioning theory (with activities as the core determinant of advantage) and resource-based view (with resources as the core determinant of advantage) in a common framework. The outline of a framework for integrating the best thinking from multiple disciplines is sketched. An example of resource accumulation is used to demonstrate the utility of system dynamics modeling in integrating a discussion of the importance of assets, activities, and managerial choices in strategy. Finally, we perform a preliminary assessment of the conceptual framework for the integrative theory against the seven benchmark criteria identified.

Finally, we present the design of a model that is being developed as an experimentation field for the integrated theory of strategy. The model is being developed to codify the patterns of commitment to activities and resource accumulation that characterizes superior performance, and just as importantly, to search for the causes of corporate problems that are observed frequently in firms.

Towards A Dynamic Theory of Strategy

Over the previous two decades, positioning theory has been well researched and accepted as providing key insights into strategy. But it is also well-known that positioning theory deals primarily with only the static aspects of competition. To move towards a more complete understanding of competition between firms, we need a theory that explains the dynamic issues of competition, and to understand the relation between the static and dynamic. The framework that integrates the static and the dynamic theories has been termed the integrated theory of strategy. But prior to any integration, we first have to develop a dynamic theory of the firm.

This chapter moves towards such a theory by examining the criteria for developing a dynamic theory of strategy. These criteria serve as challenges for the intended dynamic theory and should be used to guide the development of the theory. Three streams of research—game theory, commitment theory, and the resource-based view of the firm—are assessed against the criteria for the dynamic theory.

CRITERIA FOR A DYNAMIC THEORY

A dynamic theory of strategy seeks to explain the *dynamic processes* by which firms achieve superior positions. Internal interactions between the business functions of a firm, interactions between a firm and its environment, and the interactions between a firm's competitors are examples of such dynamics processes. Dynamic

processes occur simultaneously and continuously over time; moreover, the nature of interactions that make up dynamic processes also evolve with time. In developing a theory that presumes to provide explanations of such complex behavior one needs to give special attention to certain issues -- the scope of the theory, the concurrency of phenomena, the time horizon over which behavior is studied, the focus on causality, the ability to cope with detail and dynamic complexity, and the confidence we have in the premises offered.[8]

Completeness of Scope

The scope of dynamic interactions covered by a dynamic theory must include the firm *and* the broader environment in which it operates. Traditionally, researchers have dichotomized the study of strategy into an analysis of the industry and an analysis of the firm. Their efforts have focused on different points in the picture, but we still need to connect the dots. Disparate studies focusing either on the industry or the firm have yielded little insight on the feedback effects between the firm and its environment. Porter's *diamond*[9] attempts to find the connections but restricts its search for the origins of competitive advantage to the environment. The resource-based view of the firm places a strong emphasis on the internal resources of a firm; but competitive advantage derives from more than just resources. Game theory treats strategic action and reaction; but is limited by its concepts of mutually consistent equilibria. What is required is not more analysis of the pieces, but their *synthesis* to form a complete picture.

The theory needs to strive to be comprehensive enough to explain the primary interactions within a firm and between the firm and its industry, while still allowing for exogenous change in areas such as buyer needs, technology, and input markets. A theory must also provide latitude to the firm not only to choose among well-defined options but also to create new ones. In short, the theory needs to be complete in scope while still retaining it's ability to manage complexity.

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[8] See also Porter (1991)

Concurrency of Actions

Dynamic processes between the firm and its industry occur *simultaneously* and *continuously*. In addition to including the major players, the theory needs to address how these entities and their interrelationships continue to evolve with time. The role of timing is critical as evidenced by studies of firms where the particular timing of strategic actions have led to strong advantages like moving first to capture the initial growth of the market or moving late to clone exisiting technologies with lower costs.

An understanding of the several concurrent processes in the firm is essential to achieving consistency of action. However, the lack of appropriate tools and the restrictions of our cognitive abilities have forced us to treat concurrent processes sequentially. The need for new tools and techniques to deal with dynamic complexity is vital to an understanding of business interactions, and offers a major challenge to developing a dynamic theory of strategy.

Time Horizon

Another challenge for a theory of strategy is the time horizon over which to measure and understand success. Must theories be developed to explain success over a time span of a few years or several decades? Different time horizons will almost certainly require focus on different variables. Factors that can be considered relatively constant in the near future become variables over a longer time horizon. The importance of chance or accident is relegated to the background in favor of continuous innovation in the determined pursuit of superior performance.

The choice of time horizon itself can affect the success of a firm. Will the prescriptions for success in the short-term promote or preclude success over a longer horizon? The chosen strategic direction commits the firm to certain paths that influence and constrain future choices. A change in direction is often dramatic and usually requires extreme situations. A successful short-term strategy could very well

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[9] See Porter (1990)

doom the firm to failure in the future. On the other hand, strategies that offer success over the long-term at the cost of a painful intermediate transition can be very hard to implement.

Chain of Causality

With myriad variables affecting one another and being affected in return, causality in complex systems often seems blurred. Correlations look deceptively like causality, and symptoms forewarning corporate illness defy diagnosis. The search for the right levers to pull can be confounding—what was the 'right' lever last time might no longer be effective. A theory needs to focus strategic interventions on the *causes* and not outcomes of success. A theory of strategy should answer the question of where to focus efforts in the chain of causality.

Finding the right point of intervention also requires knowing where to draw the boundary between exogenous and endogenous variables. Does one consider the environment as a given? How far back does one go in the chain of causality? Moving backwards in the chain of causality often means crossing the boundaries between functions internal to the firm and the boundary between the firm and its environment. Sources of competitive advantage outside the firm may not be as valuable (or enduring) as sources internal to the firm. For instance, resources internal to a firm, say skilled SQL programmers, that are considered valuable in differentiating the firm from its competitors may only be valuable due to factor market scarcity (read shortage of skilled SQL programmers) in the environment. A competitor could wipe out this differentiation advantage by outsourcing its programming needs to countries like India with abundant programming manpower.

Finding the driving causes of superior performance is not enough. A firm needs to know which of these causes it can control. Typically, sources of advantage internal to the firm can be more easily controlled than sources external to the firm. In the example above, the availability of skilled SQL programmers differentiates the firm's database products from the competition. But since the availability of SQL

programmers in the market is not under the control of the firm, the firm's success cannot endure solely because of an advantage arising from conditions in the environment.

Coping with Complexity

A primary challenge for theory is to develop abstractions that manage the complexity of the real world. The theory needs to capture the detailed complexity of the number of variables and the dynamic complexity of their interactions. The abstractions found in the research on strategy include frameworks and models. Frameworks attempt to capture more complexity by encompassing a larger number of variables and pose questions to the user early in the process of strategy formulation. Models necessarily abstract from the complexity of competition and isolate few important variables whose interactions are then examined thoroughly. The two approaches—the modeling approach and the frameworks approach—complement each others strengths, and should be used together to develop a consistent and comprehensive theory of strategy.

The dynamic theory should strive to provide the analytical techniques—be they models or frameworks—to structure problems, and the tools required to solve them.

Confidence in the theory

The last criterion concerns the ability to test the theory against reality. Understandably, it is difficult to perform rigorous (read statistical) tests on models and frameworks that form the basis of a theory of strategy. Models need to be tested on more than their ability to replicate observed behavior if they are to be used as a basis of the theory. Models built with unrealistic assumptions like "a 2 player environment where each player acts sequentially and is perfectly rational" give these models little practical utility in real markets where the numbers of players is constantly changing, players act concurrently, and the rationality of each player is, at best,

bounded by their perspective and the quality of their information. Rather than to reflect optimized behavior in a perfect environment, models need to be be built to reflect reality as it is, with its imperfections and distortions, if models are to be useful in understanding *real* behavior and educate interventions in *real* business situations. Our confidence in a model needs to be predicated upon the model's utility in informing our actions in real situations.

Frameworks are accepted and used primarily for their utility in facilitating the processes of problem conceptualization, and for their aid in defining and aiding the more rigorous modeling process. Frameworks should be used in defining the scope of further analysis and in focusing initial effort on the areas needing the most attention. However, the complexity of frameworks usually runs ahead of available data.

Rather than by way of statistical tests, the question of confidence can also be approached to mean the *usefulness* of the theory for a particular purpose. The usefulness of a theory in providing tools to approach a problem cannot be belittled. The use of case studies in strategy research (*ex post* discussions of firm performance) and the use of the information embedded in mental models (contrast with measured data) promise to provide alternative routes to build confidence in a theory.

The seven criteria -- completeness of scope, concurrency of actions, time horizon, chain of causality, coping with complexity, and confidence -- are some of the key challenges that need to be addressed as we develop a dynamic theory of the firm. With more experience working with dynamic problems, more criteria can be added on to this list, but these seven criteria serve as a basis to start moving towards a dynamic theory of the firm.

Scholars in economics, strategy, and organizational behavior inspired by the promise of finding insight into the dynamics of competitive strategy have taken up the challenge of developing a dynamic theory. Three streams of research that have surfaced in recent years promise important contributions to the dynamic theory.

THREE STREAMS OF RESEARCH

Game theory, commitment theory, and the resource-based view of the firm (RBV) are three streams of research that offer promise in developing the dynamic theory of a firm. Each of the streams provide important contributions to a dynamic theory. However, benchmarking contributions of these theories against the criteria reveal that each theory focus on a somewhat different aspect of the dynamic problem. The value of game theory, commitment theory, and RBV lies in their *component* contributions to the dynamic theory and not in providing a context for an overall framework to study the dynamics of competition.

Game theoretical models

Game theoretic studies seek to understand the equilibrium consequences of patterns of choices made by competitors over a variety of strategic variables like manufacturing capacity or R&D. The central concern of game theoretic modeling is to understand conditions that lead to mutually consistent equilibria and the nature of these equilibria. Research in game theory highlights the importance of information and beliefs about competitive reaction and the conditions required for a set of internally consistent choices among rivals.

Although game theory has much to offer towards an understanding of dynamic interactions, it suffers some inadequacies. The scope of game theoretic research is limited to interactions between firms; the environment is considered constant. Some attempt is made at concurrency by interleaving action and reaction but the choices made are sequential, not simultaneous. Game theory recognizes that timing is essential but is silent about the time period of the actions. It lacks the detail complexity of frameworks because it deals with few variables and holds fixed variables (like the environment and simultaneous competitive reactions) that are in reality changing. The focus is well centered on the actions of the firm in the chain of causality, but building confidence in the results by comparing against reality is being proved a difficulty. The biggest contribution of game theory seems to be in

understanding the sequences of strategic action and reaction between competing rivals, and not in providing a context for a dynamic theory.

Commitment and uncertainty

Commitment theory deals with the issues of making irreversible commitments under uncertainty. The central premise of commitment theory is that a firm's strategy is manifested in relatively few investment decisions that are hard to reverse. These few decisions then constrain and influence choices in other areas of the firm. Strongly related to commitment theory is work that includes defining ways of understanding the uncertainties a firm faces, and the alternative strategic choices that firms make in response to uncertainty. The behavioral decision strain in commitment theory recognizes that biases and heuristics—characteristic of decision making in complex and uncertain circumstances—distort the strategy choices of a firm.

But commitment theory does not address important dimensions of the dynamic theory. The focus is on large discrete sequential investments rather than a simultaneous set of choices throughout the value chain. The environment is considered relatively stable so commitments have long-lived consequences and the possibilities for reconfiguring are limited. The theory advocates the value of flexibility in reacting to change rather than the firm's capability to create change and shape its environment.

Resource-based view of the firm

Most introspective of the three streams of research, the resource-based view of the firm (RBV) centers on the firm and the resources it possesses. RBV maintains that the origins of competitive advantage lie in the valuable resources that a firms possesses. Resources are seen as strengths to be nutured, and the resource position of a firm should guide the choice of strategy. The implications are that a company should be looking for superior resources that are valuable, inimitable, and non-appropriable.

The promise of RBV theory lies in its efforts to address the dynamic processes that allow firms to achieve and sustain favorable competitive positions over time.

RBV theory comes close to providing a dynamic theory of strategy. The emphasis on internal resources suggests a long-term perspective to achieving and sustaining advantage. However, there is little treatment of the environment of the firm beyond that of factor markets for acquisition of assets. The inward focus on resources often overlooks competitor behavior and customer needs. Changes in the environment and the immobility of resources are just as likely to make exisiting resources a liability; the influence of the environment on a firm's success cannot be ignored. There is need to extend the scope of RBV theory to include the environment and account for causal factors of success that lie outside the firm.

Of game theory, commitment theory, and RBV theory, the resource-based view of the firm comes closest to providing a dynamic theory due to its emphasis on evolving resource positions over time, and the emphasis RBV places on a longer time horizon. Also, with its focus on finding the origins of competitive advantage within a firm, the resource-based view provides a complementary perspective to positioning theory that focuses on sources of advantage in the environment. The next chapter discusses how the concepts from the resource-based view and positioning theory can be integrated.

An Integrative Theory of Strategy

We have set out to take a fundamental look at the business of firms and to gain an operational understanding of the factors responsible for superior performance. The first chapter discussed the motivation behind trying to translate between the tools and techniques of traditional strategic management and that of system dynamics. The second chapter presented seven criteria that need to be addressed in developing a dynamic theory. Three promising streams of research -- game theory, commitment theory, and the resource-based view -- were assessed against the seven criteria.

In moving towards a complete theory of strategy, we have recognized the contributions of the resource-based view, commitment theory, and game theory in complementing positioning theory. However, benchmarking the component theories against criteria defined for a dynamic theory of strategy reveals deficiencies even with the combined body of resource-based view theory, game theory, and commitment theory. In this chapter, we suggest how these deficiencies can be filled using an approach suggested by Porter.[10]

Figure 3.1 shows our progress towards identifying the components of an integrated theory of strategy. The "?" represents the missing components of our

[10] See Porter (1991)

integrated theory. This chapter will aim to fill that missing component. Also, we use an approach suggested by Porter - that of decomposing the "theory of strategy" into a cross-sectional (read static) component and a longitudinal (read dynamic) component. The approach works well in mapping the contributions of component theories to the cross-sectional and longitudinal problems, but does little to suggest how they should be integrated to form an integrative theory of strategy. After identifying the missing component of the dynamic theory, we sketch the outlines of a framework to achieve the integration.

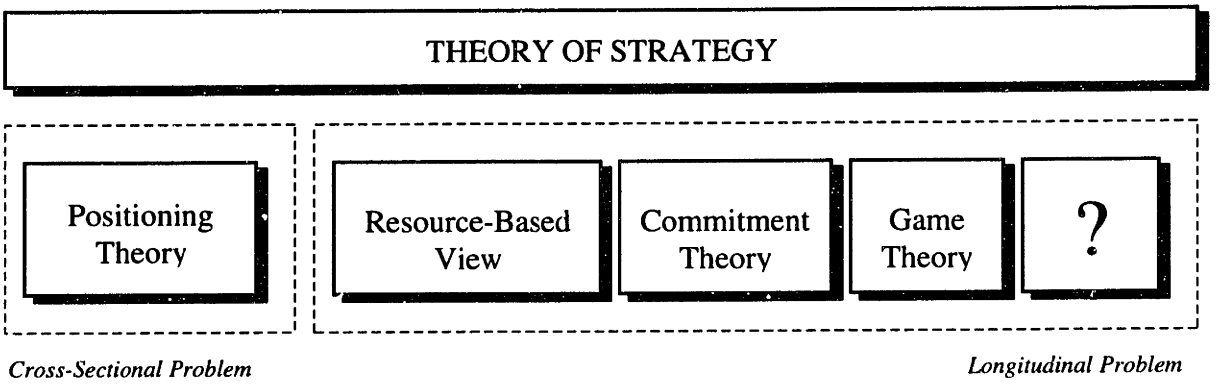

Figure 3.1 Towards a Theory of Strategy

RBV theory, with a strong internal focus on the firm, suggested the most promising contributions to a dynamic theory, but RBV lacks a complementary external focus on the environment and market. Due to the importance Porter's positioning theory places on the environment-competitors, customers, and suppliers-chapter two concluded by suggesting the marriage of two important streams of research in traditional strategic management -- positioning theory and the resource-based view. This chapter begins to strengthen the linkages between positioning theory and the resource-based view by proposing a framework that uses system dynamics to integrate and extend positioning theory and RBV theory. We start discussing the integrative framework by getting down to the basics.

INTRODUCTION

At a fundamental level, the success of a firm in an industry is a function of two areas: the *attractiveness of the industry* and the *firm's market position* in the industry. The attractiveness of an industry depends on present and potential competition, the bargaining power of customers and suppliers, and the threat of substitution to the products and services offered by the industry.[11] A firm's market position depends upon how customers value the firm's products and services relative to those of competitors. Success can be measured in several ways. For purposes of the discussion here, success is measured by profit cumulative over time. Profit depends upon the margin (of price over cost) and sales volume of a firm's goods and services. The attractiveness of an industry and a firm's market position affect both the margin and the sales volume of a firm.

Porter has researched both the issues of industry attractiveness and competitive position. In *Competitive Strategy* (1980), he described the determinants of industry attractiveness through the five forces framework, and presents three generic strategies that codify efforts of a firm to achieve a superior market position. A superior market position is considered to result from competitive advantages that the firm possesses over its rivals. Porter's three generic strategies seek to acquire a cost advantage, differentiation advantage, or either advantage within some scope. Both cost and differentiation advantages serve to increase margin and sales volume of the firm. In *Competitive Advantage* (1985), he describes the way a firm can choose and implement a generic strategy to create and sustain competitive advantage over its rivals, and presents the value chain framework as a tool to diagnose competitive advantage.

Although the primary purpose of Porter's research was to study the causes of superior performance at a given point in time, he also recognized that both industry attractiveness and competitive positions change with time. It is not enough to seek out the structural determinants of a firm's superior position at a point in time, but more important, to understand how the determinants change with time and how firms can

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[11] The five forces—present competition, potential competition, customers, suppliers, and the threat of substitution—form the basis of the *five forces framework* in Porter (1980).

control them. Six years later, in 1991, Porter's paper *Towards a Dynamic Theory of the Firm*[12] posed the problem of understanding how competitive positions change over time as one of the primary challenges for strategy. Porter comments: "While there has been considerable progress in developing frameworks that explain differing competitive success at any given point in time, our understanding of the dynamic processes by which firms perceive and ultimately attain superior market positions is far less developed. Worse yet, some recent research has tended to fragment or dichotomize the important parts of the problem rather than integrate them..." Porter recognizes the need for an integrative theory of strategy that incorporates an understanding of dynamic processes within the existing body of knowledge in strategy. He observes that recent research has not taken such an integrative perspective. A theory of strategy, however, needs to go beyond observing that there is a need to understand competitive dynamics to learning how this can be achieved.

Porter's paper separates the theory of strategy into two problems: the *cross-sectional* problem that studies the causes of superior performance at a given period in time, and the *longitudinal* problem that studies the dynamic processes by which these positions are created. The paper evaluated three streams of research (discussed in the previous section): game theoretic modeling, commitment theory, and the resource-based view of the firm. Porter's complaint that these theories fragment the dynamic problem and solve only parts of it is well-founded; but should be interpreted to indicate the difficulty of the longitudinal problem rather than the inadequacy of any component theory. Indeed, it is the intention of this thesis to provide the theoretical foundation to help integrate the results achieved in these three streams of research.

Prior to the discussion on such an integrative theory of strategy, four observations need to be made. First, although the determinants of superior performance have been separated into the two factors of industry attractiveness and the firm's market position, this separation is only a simplification. In reality, the attractiveness of an industry and the firm's market position are interrelated. Industry structure is partly exogenous (outside the direct control of the firm) and partly subject

[12]See Porter (1991)

to influence by the firm's actions. The firm's actions influence industry both directly through it's products and services, and indirectly by evoking reactions from the competition (and sometimes even regulatory bodies). Understanding and using the firm's scope for influencing industry structure is of critical importance in achieving market leadership. On the opposite side of the relationship, the industry constrains and influences the actions of the firm. Porter's work on positioning has extensively explored the effect of the environment on the firm, but does not show the same rigor in understanding the effect of a firm on its industry. An integrative theory of strategy must investigate the intimacy of the *mutual* relationship between a firm and its industry, and be able to explain the nature of evolution of this relationship over time.

The second observation concerns the curious relation between the cross-sectional and the longitudinal problem. Both problems seek to explain superior performance of a firm within an industry, and both add an important dimension to the integrative theory of strategy. The cross-sectional problem explores the success of firms across the *space* dimension, while the longitudinal problem recognizes the importance of the *time* dimension. However, the possibility of conflict arises from the prescriptions each problem offers for the strategy of the firm. A strategy seeking to prescribe success over a three year time frame will look very different from one with a thirty year time frame. Firms must continually choose to allocate their limited resources between activities that yield strong positions in the established markets of today versus activities that hold only the possibility of an advantage in the uncertain markets of the future. For instance, a firm needs to prioritize between investing in innovations of an existing line of products and investing in long-term research for a radically new technology. A firm must be able to compete cross-sectionally and longitudinally. Our approach will therefore be to start our discussion of the integrative theory by discussing the relation of the cross-sectional problem to the longitudinal problem.[13]

[13] We will not examine the analytical techniques used to solve the cross-sectional problem. These have been explored sufficiently in Porter (1980) and Porter (1985). Instead, we focus on the aspects of the cross-sectional problem that relate to the longitudinal problem.

Third, the ability of a firm to *sustain* its competitive advantage cannot derive merely from the type of generic strategy it follows—a cost-advantage strategy or a differentiation strategy. A firm cannot hope to sustain advantage over its rivals if the advantage derives from a *generic* strategy that the rivals can "generically" imitate. The fitness of a firm might show up as the ability of the firm to produce at lower cost or provide more value; but why are some firms better than others in developing this fitness? Possibly the secret to superior performance lies not in the type of advantage the firm has—cost or differentiation or both—but in *how* the advantage was created. The integrated theory needs to address the issue of how these advantages are attained and why they are not easily imitable.

A final observation is that dichotomizing the types of advantage into cost or differentiation advantage seems to indicate that pursuing either one is sufficient to ensure success. Not true. Cost advantages cannot be pursued by sacrificing customer value and neither can differentiation be sought with little regard to cost. A low quality product albeit one with low costs is unlikely to afford the firm a superior market position. The customer usually wants a good product *and* a good price. [14] It is possible, as several successful firms have showed, to achieve *both* cost and differentiation advantages simultaneously. A close look at the structural determinants of cost and differentiation advantages suggested by Porter's empirical research reveals that many of the same drivers can create both types of advantage. Policy choices, linkages, timing, location, interrelationships, scale, learning, integration, and institutional factors drive the creation of both cost and differentiation advantage. Why, then, do some firms get stuck in the middle pursuing too many advantages, while other firms are able to deliver on all dimensions? Why are some firms able to use these drivers to create advantage while other firms are unable to do so? The integrated theory must offer an explanation of why drivers work better for some firms than others.

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[14]But Porter warns against the perils of pursuing both cost and differentiation advantages and getting "stuck in the middle" with a product that has neither a cost benefit nor a differentiation benefit.

The four observations provide us with four focal issues in developing the framework for an integrative theory -- the influences of industry attractiveness and a firm's market position on each other, the contributions of cross-sectional effects and longitudinal effects to superior performance, the processes governing how competitive advantages are created, and the reasons why drivers work only for some firms.

The reasons behind superior performance can be decomposed into an industry attractiveness effect and a market position effect. To understand the nature of the industry attractiveness effect, we will study the interactions of the firm, its customers, and the competition. The firm's market position is a function of the attractiveness of the firm relative to the competition. We will seek out those attributes of the firm that make it more attractive (than the competition) to the customer. The effects of the firm on industry attractiveness will be explored, but other aspects of industry attractiveness like geographic location and regulatory controls are not treated in this thesis. We continue to decompose a firm's success into it's elemental reasons behind the success. At this point it is also appropriate to also introduce the dimension of time by discussing success in the context of the cross-sectional and longitudinal problems. We start with the cross-sectional problem.

THE CROSS-SECTIONAL PROBLEM

The cross-sectional problem studies the causes of superior performance of a firm at a point in time. Cross-sectional frameworks address the choice of strategy given whatever array of capabilities the firm and its rivals possess at a point in time. Firms inherit positions that constrain and shape their choices and environmental circumstances are linked with firm behavior to produce market outcomes. Given industry structure, the firm's circumstances, and the positions of competitors, success depends on the choice of a strategy to develop a relatively attractive position and the ability to bring all the activities of the firm into consistency with the chosen strategy. The assets of a firm are considered relatively constant in the cross-sectional problem; the emphasis is on the activities a firm can perform with those assets.

The cross-sectional problem poses the questions - what makes some industries and some positions within them more attractive than others? What makes particular competitors advantaged or disadvantaged? What specific activities and drivers underlie the superior positions? To answer the first question, we must first find answers to the second and third questions. We take up these questions in turn—first to understand the nature of competition, and then the role of activities in creating superior positions. The next section discusses competition between firms in terms of the cross-sectional problem and its relation to the longitudinal problem.

Competition

Firms compete with each other every day in the marketplace. A customer walks into a store or browses through a catalog to compare the value one firm offers relative to another. This competition on price/performance characteristics of the product includes the attributes of a product *and* the firm that is important to the customer. Commonly found among these attributes are price, quality, service, technological differentiation (product newness), availability, and brand reputation. The customer makes a purchase based on his or her perception of the value provided by the product or service. It is the role of a firm's advertising and sales to educate this perception in favor of that firm.

Firms also compete on their ability to develop new technologies, produce new products, and create new markets. Firms need to develop capabilities that allow them to continually innovate and improve the activities within a firm. Innovation within a firm includes both product and process innovation. The activities a firm performs then creates cost and differentiation advantages over time. Later, we study the specific nature of the capabilities and activities of a firm that create advantage.

The nature of competition, as seen from the perspective of an integrative theory of strategy, is multi-dimensional. Firms compete in the short-run on the ability to provide greater value for the particular product or service, and in the long-run on the ability to develop entirely new product lines and offer new and better services to customers.

The challenge of winning at competition, however, is made more complex due to three reasons:

1. Firms cannot alternate management attention between the so-called short-term competition and long-term competition. There is no clear dividing line between what constitutes short-term as opposed to long-term. It might be possible to distinguish between the two based on product development times and the expected length of product life cycles in the industry. But forecasts about product life cycles have been notoriously wrong, rapid innovations in technology continue to shrink development times, and it is hard to put a time frame on the development of new technologies. Moreover, product and process innovations occur simultaneously in a firm.[15] Competition is often treated along different time scales, but in reality it is continuous, making it difficult for a firm to succeed by alternating attention between competition in the near versus distant future. The time horizon of planning for a firm needs to be longer than the next quarter, or the fiscal year, or even the five year plan.

2. A firm might take a long-term view in planning, but in the immediate present a firm's budgeting prioritizes the allocation of its resources between projects aimed at improving the price/performance characterisitics of an existing line of products versus projects that aim at developing new product lines. The returns from the former projects carry less risk as they involve competition for a certain product in a known market with familiar rivals, while the markets, the competition, and the products of tomorrow are, at best, uncertain. The decisions that prioritize the present allocation of the firm's resources also impact the future capabilities of the firm. The decisions made today often carry long-term consequences for the firm. The strategy of a firm is usually manifested in the form of a few large, hard-to-reverse investments that commit the firm to certain paths into the future. Moreover, firms are reluctant to make dramatic changes to their strategy. This nakes it important

[15] See also Utterback (1994)

for firms to understand how their present decisions affect their ability to compete in the future.

3. A product's attributes that dictate the dimensions along which customers measure value often change with customer tastes and the life cycle of the product. Equally important, the attractiveness for the goods and services of a firm is the *multiplicative product* and not the sum of the attractiveness of each of the attributes. It is not enough to have a product that enjoys a strong cost advantage but suffers low availability; a firm must deliver on all dimensions. Furthermore, firms must continually monitor the changing tastes of the customer (in each niche that the firm serves) and maintain the ability to offer value on each of the attributes.

The nature of competition is complex, and firms need to possess capabilities that allow them to provide better customer value in the markets of the present *and* the future. A firm might be crushing the competition due to advantages that the firm commands today, but will those advantages endure over the next 20 years? Over a longer time horizon, a firm competes not on advantages, but on the *capabilities* of the firm to continually create advantages. But what are these capabilities and how does a firm acquire them? One view is that a firm's capabilities derive from the firm's present resource position and market power. Highly successful firms possess resources and market power that make them formidable competitors. But history has shown repeatedly that highly successful firms often fail to sustain their success, and smaller firms with fewer resources have frequently upstaged larger firms. Large firms usually do have greater resources, but small firms have been able to develop stronger capabilities. The ability of firms to develop better capabilities than other firms goes beyond the resource position of a firm. The next section examines the relation of resources to capabilities.

Capabilities

Resources are not valuable in and of themselves, but because they allow firms to perform activities that create advantages in particular markets. Resources are only meaningful in the context of performing certain activities to acheive certain

competitive advantages. Resources arise from performing activities over time, acquiring them from outside, or some combination of the two. Some firm attributes termed resources are actually activities—such as sales forces or R&D organizations. A more appropriate category of resources is skills, organizational routines, or other assets attached to particular activities or groups of interrelated activities. When these skills, routines, and assets are put together to create a product or service with superior price/performance characteristics, the particular uses of a firm's resources create capabilities for the firm.

Capabilities, then, are those attributes of a firm that allow it to create products and services with the characteristics that customers value. The ability to get products to market first and insure the availability of a product in times of rising demand are two examples of capabilities of the firm. The capabilities of a firm can be measured along the three dimensions of speed, cost, and quality. A firm should not be preoccupied with building static market share, but instead should develop organizational capabilities that allow the firm to move quickly in and out of products, markets, and even businesses.

The capabilities of a firm transcend the barriers of individual activities performed within the firm. For instance, to be capable of getting products to market first requires coordination across several activities of the firm like product development, manufacturing, marketing, and sales.

The capabilities of a firm are a function of the resources of a firm, but probably more so of the firm's *resourcefulness*. The way an organization uses, supplements, and upgrades its resources to build new competitive advantages is termed resourcefulness. Firms with fewer resources are able to develop superior capabilities because of their ability to better *leverage* their resource position than other firms. Such firms are able to overcome their resource disadvantages by making better use of the few resources that they do have.[16] Successful firms achieve leverage by stretching the resources they possess and finding more creative ways of using their resources.

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[16] See also Hamel, et al (1995) for a description of ways in which firms can leverage resources.

The capabilities of a firm help it create products and services with value, but what does the recognition of capabilities prescribe for strategy? The influence a firm can exert upon industry derives from it's present market position, and in turn helps determine the firm's position in the future. Market position (or relative position in an industry vis-à-vis competition) however, is an outcome and not the cause of competitive advantage. We ask how or why did a firm attain an attractive market position? The answer suggested by Porter is: the firm must possess a competitive advantage over it's rivals. This competitive advantage could derive from one or more of several capabilities of a firm, and often derives from a particular combination of capabilities that a firm possesses at that point in time. The recipe for success then seems to be simple: acquire the set of capabilities that will give your firm a competitive advantage. Easier said than done.

To seek out and acquire capabilities that will create advantages requires different choices about the types of advantages sought and the scope of those advantages. Often firms discover logical inconsistencies in their strategies to pursue several types of advantage or scope simultaneously. The essence of strategy is choice; the essence of success lies in consistently making the correct choices. Consistent choices provide the firm with a distinct position in the market. In addition to resources, managerial choices and activities of a firm are crucial to developing capabilities.

Capabilities are a function of a firm's leveraged resources, activities, and managerial choices that define what resources are acquired, when they are acquired, the proportions in which they are acquired, and how activities are configured to make the best use of resources.

The causality between a firm's strategy to pursue competitive advantage and actual creation of an advantage is still unclear. To understand the nature of this causality we require an operational footing to abstract concepts like "competitive advantage." We need to find the origins of competitive advantage before we can manage the creation of advantage. We have already begun to operationalize competitive advantage by decomposing it into the factors that create it. A firm

produces a superior product because it possesses the capabilities to do so. The capabilities of a firm are directly related to resources of the firm and its ability to leverage those resources. A firm's ability to leverage resources depends on the managerial choices made. Leveraged resources are used in performing the *elemental activities* of a firm in ways that that ultimately drive competitive advantage. In the next section we turn our attention to these activities of a firm.

Activities

A firm is a collection of discrete and interrelated activities that are performed to design, produce, market, deliver, and support its line of products and services. Porter categorizes these activities as primary activities and support activities. The primary activities of the firm—inbound logistics, operations, outbound logisitics, marketing and sales, and service—are the activities involved in the physical creation of the product, its sale, and after-sale service. The support activities of the firm—procurement, technology development, human resource management, and overall firm infrastructure—provide the firmwide functions necessary to support the primary activities. It is the performing of these primary and support activities that provides a firm with capabilities to compete in a market.

The way these activities are performed reflect a firm's strategy, the implementation of the strategy, the history of the firm, and the inherent economics of the activities themselves. According to Porter, competitive advantage results from a firm's ability to perform the required activities at a lower cost or in unique ways that creates buyer value. The basic unit of competitive advantage is, therefore, the discrete activity.

Equally important to asking how individual activities are performed is the question - How are the various activities of the firm interrelated? Earlier ideas in strategy like the business system concept[17] developed by McKinsey & Company advocated that useful insights could be obtained by analyzing how each function of the firm was performed relative to the competition. But the business system framework

[17]See, for instance, Gluck (1980)

did not show how these functions were interrelated nor how they created competitive advantage. Much attention has been given to optimizing the discrete activities of a firm, but little progress has been made in understanding how these activities work together to create advantage. Porter stresses the need to understand and use the linkages between activities to develop competitive advantage, but offers little by way of analytical tools and techniques to actually understand linkages. The effort to understand linkages continues to be an important research area in strategy because a firm's strategy is manifested in the way it configures and links the many activities in its value chain relative to the competitors. Linkages also extend outside the firm to the activities of suppliers and buyers. The concept of linkages begins to operationalize the notion of internal consistency between the many activities of the firm and is key to achieving superior performance. We will return to the concept of linkages to understand how activities are interrelated. But first we look at some of the issues in how activities are performed.

Performing activities in a firm requires purchased inputs, assets, information, and as Porter calls it, a 'technology' to perform them. This technology to perform activities is broadly defined to include the organizational routines of the firm. Organizational routines represent the rules, habits, and heuristics that are used to guide decisions; we term the 'technology' to perform activities the *policies* of the firm. The internal assets of a firm can be tangible like physical and financial assets, or intangibles like knowledge and level of technology. In addition to internal assets, the firm can also possess external assets that include tangibles like contracts and technical collaborations, and intangibles like brand reputation. Intangibles like information and organizational routines play just as important a role, albeit a less studied one, in performing activities as the tangible assets of the firm. A firm needs to look beyond managing tangible assets that can be acquired internally to developing the ability to manage the acquisition of intangible assets, and developing partnerships that can generate external assets for the firm.

The acquisition of assets is important because the nature of assets a firm possesses allows it to perform activities in unique and non-imitable ways. Much

attention has been given to the problem of resource allocation, but little to the challenge of resource *accumulation*. Activities are intimately related to assets; not only do activities consume assets, but performing activities also creates assets like skills, knowledge, and reputation. To understand resource accumulation we need to recognize that the assets of a firm accumulate and depreciate over time. The tangible assets of a firm naturally depreciate with time, while activities like advertising can cause intangibles like brand reputation to accumulate over time. However, intangible assets like skills and knowledge can also depreciate with time due to obsolescence and changing customer needs. The firm needs to manage the processes of accumulation and depreciation of its assets if it is to perform activities in ways that create advantage.

We have made the argument that performing activities in *special* ways creates competitive advantage. We noted the need to understand not only how activities are performed but also how performance of each activity relates to other activities. Activities require assets, purchased inputs, information, and organizational routines that help determine how activities are performed. A firm needs to manage the accumulation of resources alongside the problem of allocating resources internally. Performing activities gives a firm certain capabilities that allow the firm to produce superior goods and services. Moving down the chain of causality, we now need to understand why some firms are better able to perform their activities than others.

The only tool (mentioned so far) used to help understand why some firms perform activities in special ways is Porter's value chain. But the value chain is a static framework. Managers face the challenges of discovering interrelationships between performance of activities, mapping linkages between them, managing accumulation and depreciation of assets, and in understanding use of information and organizational routines or policies in making decisions; the value chain offers little help. Moreover, we know even less of how relationships between activities change over time, and how they create competitive advantage. Our understanding of competition, capabilities, resources, and activities has brought us closer to the origins of competitive advantage, but we have only part answer to the question: Why were particular firms able to get into advantaged positions and sustain/or fail to sustain

them? To complete the answer we have to enter the realm of what is termed the *longitudinal* problem.

THE LONGITUDINAL PROBLEM

The longitudinal problem seeks to understand the dynamic processes by which firms achieve superior positions. Why do firms achieve favorable positions through the activities they perform? How can the timing of a firm's actions affect advantage? Why do some firms conceive of activities in radically different ways or spot entirely new and desirable competitive positions?

According to Porter, some firms perform better than other due to two reasons - *initial conditions* and *managerial choices*. Firms may have pre-existing reputations, skills, and activities as a result of their history. These "initial conditions" are actually the *present conditions* of a firm or its environment.[18] The initial conditions of a firm (initial to the present moment in time for an existing firm), like base of loyal customers, specialized technology, and investments in R&D, clearly influence the feasible choices open to a firm as well as constrain them. Firms also achieve favorable positions through creativity of its managerial choices. Managerial choices define a firm's strategy for competing, the configuration of its activities, and the supporting investments in assets and skills. Pure managerial choices lead to assembly or creation of particular skills and resources required to carry out a new strategy. Several highly successful firms, like WalMart, Federal Express, Apple Computer, and American Airlines had few initial strengths and have risen to success largely due to their creativity in out-thinking the competition.

The initial condition of a firm can be assessed in the way a firm performs its activities, the assets that the firm possesses, and the capabilities these assets afford the firm. Managerial choices determine how these activities are configured, what assets are acquired, and what information is used in making decisions. Organizational policies decide how the resources and information available is used to make decisions.

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[18] Porter uses the terms "initial conditions" to mean "present conditions" of a firm initial to the present moment in time. The present conditions of a firm change with time, and become the initial conditions to a new moment in time in the future.

Initial Conditions and Managerial Choices

Many strategies clearly reflect some combination of initial conditions and creative choice. However, there is reason to focus our attention primarily on the managerial choices made in a firm. Responsible for all initial conditions internal to the firm at a point in time are earlier managerial choices. The skills and market position of a firm today are the result of previous choices on how activities were configured in the past and what skills were created and acquired.

In the cross-sectional problem also, the importance of managerial choice is highlighted. Simply having a pool of resources is not in and of itself a guarantee of success. The resources must be the right ones and must be leveraged to create capabilities. Managerial choices are key to acquiring the right resources and putting them to their best use. If managers can understand their competitive environment and the sources of competitive advantages, they can search creatively for favorable positions that are different from the competitors', assemble the needed skills and assets, configure the value chain appropriately, and put in place supportive organizational routines and a culture that reinforces the required internal behavior.

Successful firms make better managerial choices. They are better able to align the firm's resources behind their strategy, acheive a consistency in their actions, and harness the synergies across their activities. That seems almost self-evident. The question is why? We have already hinted that superior performance lies in the ability to effectively manage change in the resources of the firm, leverage those resources to create a stronger resource position, and use the resources for performing activities that are specially configured to drive the creation of advantages. The integrated theory provides no easy recipe for success. Superior managerial choices require better information and careful analysis.[19]

Such analysis needs to map the relation between the initial conditions a firm faces at a point of time and the processes that control the evolution of the firm into new conditions. The initial conditions of a firm are embodied in its levels of tangible

[19] See Forrester (1961, appendix J) for a discussion on the use of information in decision making.

and intangible resources, the initial configuration of the firm's activities, levels of capabilities accumulated by previous activities, and the present organizational policies of the firm. The managerial choices of a firm govern the processes that change these levels of resources by determining how the assets of the firm are to be used in performing activities. The analytical tools we require must deal explicitly with the linkages between activities, and the interrelationships between activities, assets, and managerial choices. Moreover, such analytical tools need to help us understand how such relationships change with time.

Fortunately analytical tools of such sophistication exist. The discipline of system dynamics, initiated by Jay Forrester at the MIT Sloan School of Management in the early 1960s, offers the science to deal with dynamic complexity in the longitudinal problem. The theory of system dynamics draws upon information-feedback theory, behavioral decision science, and descriptive knowledge of business policy. The practice of system dynamics offers tools for modeling and computer simulation to increase the cognitive and perceptive ability of a decision-maker in dealing with complexity. Game theory with its emphasis on action and competitive reaction, the resource-based view with its emphasis on accumulating valuable resources, and commitment theory with its emphasis on path dependence offer complementary insights that enrich the research on a dynamic theory of the firm.

We are nearing the end of our search for theoretical frameworks that support an integrative theory of strategy. Some conceptual foundations have been laid; now the task of operationalizing the concepts takes on prime importance. The first step in this direction involves understanding how managerial choices are made and how they affect performance. The next section disaggregates 'managerial choices' into choices about how to behave—policies, and the actual choices that result—decisions.

Policies and Decisions

Policies and decisions are both managerial choices. A policy, however, is a managerial choice about how to behave -- policies, so defined, are often called "values" or "culture" or "the way we do business here" for a firm. A decision on the

other hand is the actual choice that results from applying a policy to a given situation. Policies define decisions.

A *policy* is a rule or heuristic guideline that states how day-by-day operating decisions are made. *Decisions* are the actual actions taken at a particular time. Decisions result from applying policies to the existing conditions in the firm and from using information available at that decision-making point to direct the action taken.[20] Policies determine how decisions are made - for this reason, changing the policies (rather than individual decisions) of a firm holds promise for greater impact on performance. Decisions control the flows of materials, personnel, capital equipment, money, and information in a firm. Decisions create flows that accumulate as resources of a firm. Also, a firm receives a flow of orders from its customers and, in return, supplies a flow of products and services.

Three important issues need to be discussed with regard to policies and decisions. First, policies and decisions directly affect the behavior of the firm by determining the rates at which the stocks of resources of a firm change. In addition, defining policies requires defining how activities are configured. The configuration of activities affects the growth of stocks, like learning, that accumulate due to performing activities over time. Second, policies and decisions in one part of the firm affect other parts of the firm. Finally, policies and decisions do not always have their intended effect on behavior. Actual behavior emerges from the interactions of the intended policy with the other policies of the firm.

For sake of illustration, let us examine how decisions and policies affect the production resources of a firm. Decisions to acquire new production equipment for expansion or to replace old equipment create inflows that add to the stock of production resources within the firm. The stock of production resources depreciates naturally with use, and explicit decisions to replace equipment may be made. Depreciation and replacement are outflows that reduce the stock of available

[20] See Forrester (1961) for a discussion of the decision process and decision functions.

production resources. The difference between the inflows and the outflows determines the rate at which the stock grows or declines.

Policies that define the firm's strategy, like for instance the firm's plans for expansion, determine the actual decisions made that change the flows into and out of the stock of production capacity. Some flows can be controlled like the inflow due to planned addition of capacity while other flows are inherent in the physics of the system like the outflow due to depreciation. The stock of production resources cannot be changed immediately however. Acquisition of resources requires time for information to be gathered, the decision to be approved, and lead-time for setting up production capacity. Only after an appreciable delay do the production resources being absorbed actually become available for use by the firm. In situations where market growth is rapid, firms that do not aggressively add production capacity ahead of market demand often find themselves losing market share. The delays in absorption of production resources leave the firm short on production capacity.

The policies in one part of a firm also affect performance in other parts of the firm. With increasing production capacity, firms also need to acquire and absorb a proportional amount of professional capacity. The dynamics of absorption of professional resources can be quite different from production resources though. A new professional is rarely as productive as an experienced one. It takes time for new hires to achieve the same levels of productivity as more experienced employees. The magnitude of delay in absorption of professional resources is usually different from delays in absorbing production resources. Such differences can cause large imbalances within a firm. In the same scenario of rapid market growth, even if the production resources can meet rising demand, and hires can be made rapidly enough (assuming no factor market constraints) the firm will end up with a lower average experience per employee. Lower average experience, which possibly results in poorer quality, is due to the large number of new hires with lower levels of experience. The lack of experience and adequate training time often manifests itself as declining service levels and increased costs for the firm. If hires cannot be made rapidly enough, or delays in

absorption are large, as they usually are, rapidly growing firms often find that further growth is constrained by lack of professional resources.

Finally, there are often discrepancies between the intentions of a strategic plan and its consequences. Emergent behavior is often different from intended behavior due to systemic interactions between different policies, and between the firm and its environment. The example of acquiring production and professional resources showed how the very policies aimed at growth then became limiting constraints to future growth. Complex systems, like those of a firm and its industry, often cause unanticipated side-effects of intervention with the system. Sometimes behavior is even counter-intuitive - and when it is, the firm pays the price for wrong intuition. What often appear to be accidents in such cases are really events driven by conditions in the system. Historical "accidents" are less common than upon first impression. It is of vital importance to understand the reasons behind unintended behavior. Although understanding the past will not help us know the future, perhaps a better understanding of the structural determinants of firm behavior in the past will help avoid making the same mistakes in the future.

Over the past several pages, we have discussed the longitudinal problem and its relation to the cross-sectional problem. Porter offers the "chain of causality" shown in Figure 3.2 to map the relation between the longitudinal and cross-sectional problems, and their interactions as determinants of firm success. The "chain of causality" however, is missing important links; noticeably, the influence of a firm's existing activities/value system on managerial choices, the absence of mention of resources/assets of a firm, the role of managerial choices in using assets in ways that create capabilities, the constraints that a firm's asset position places on managerial choices, the role of assets in activities, and the influence of firm success (or failure) on future choices and "initial" conditions. It is the success or failure of today that defines the "going-in" position tomorrow; another way of saying that the cross-sectional problem is just a snap shot of the longitudinal problem at an instant in time. The flowing of the cross-sectional into the longitudinal over time is missed in Porter's chain. Perhaps, success is not created by a chain after all.

Furthermore, Porter's chain does little to place the contributions of resource-based view theory, commitment theory, and game theory within his prescription for success. Activities determine the present conditions of a firm, but how do initial conditions change? Drivers are "structural determinants" of value - but there is no representation of structure or how it determines activities or value.

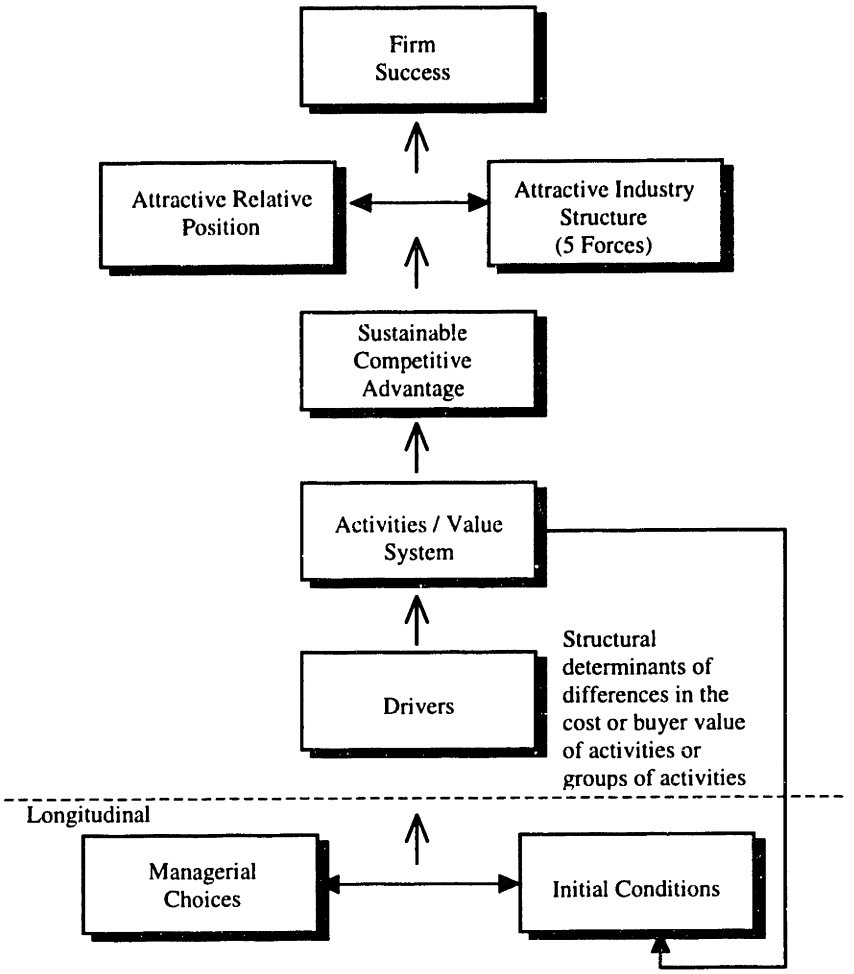


Figure 3.2 The determinants of success (according to Porter)[21]

Prior to sketching an alternative representation of the problem, we revisit our discussion of accumulating production resources, and map the process using the tools of system dynamics. Our discussion of the stylized example of resource accumulation

[21] See Porter (1991)

will demonstrate the explicitness of system dynamics representations of assets, activities, and managerial choices, and the ease with which system dynamics' tools can be used to relate the cross-sectional to the longitudinal problem.

STYLIZED EXAMPLE

We present a stylized example of a firm's resource accumulation process using stocks and flows. Our earlier discussion of resource accumulation is mapped here using stocks and flows. The production resources of a firm accumulate over a period of time due to the delays involved in making the decision to acquire new production capacity and the lead time for that production capacity to come on line. Figure 3.3 shows two stocks PROD_RSRC_BEING_ABSORBED and EFFECTIVE_PROD_RSRC with flows into and out of them. The figure is a schematic of the ***activity*** of resource accumulation for a firm's production resources.

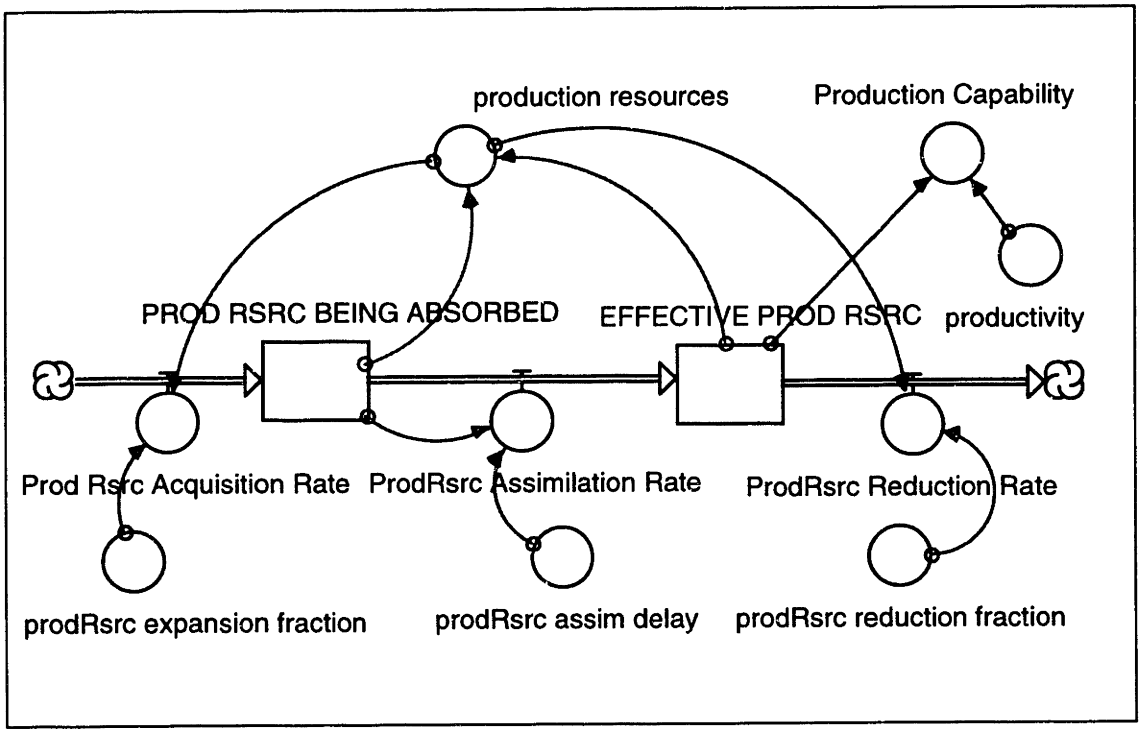


Figure 3.3 Production Resources and Capability

The stock for PROD_RSRC_BEING_ABSORBED represents the production resources that have been ordered and are coming on line. The EFFECTIVE_PROD_RSRC represents the present effective level of production resource in the firm. The

production ***resources*** of the firm at any point in time is the sum of the effective production capacity and the production capacity being acquired. The production resources represent the production ***assets*** of a firm. Each stock is an asset/resource.

The acquisition rate of production capacity Prod_Rsrc_Acquisition_Rate depends on the present level of production resources (including production capacity previously ordered but yet to be effectively available) and the fraction for expansion of production resources prodRsrc_expansion_fraction. In the figure, the acquisition rate for new capacity is defined by a ***policy*** that is modeled as the multiplicative product of the existing capacity and the expansion rate - representing a growth percentage over existing capacity. For example, if existing production resources is 200 shop-floor machines, and expansion rate is 5%, the policy for expansion determines that 10 machines should be added. The actual number of machines added, in this case 10, is the ***decision*** that was made at that instant in time. Together, the policy (to grow at a fixed percentage of existing production resource position) and the resulting decision (add 10 machines), represent the ***managerial choices*** of the firm. Managerial choices are made using information - the links from production_resources and prodRsrc_expansion_fraction to Prod_Rsrc_Acquisition_Rate represent ***information flows*** to the decision made to acquire new resources. Now, we introduce the time dimension into the process of resource accumulation.

The prodRsrc_assim_delay represents the delay in the assimilation of effective production resources. The prodRsrc_reduction_fraction is responsible for the reduction of production resources either due to removal of old equipment or due to deliberate cuts in production capacity of the firm. The three flows in the figure determine the pattern of change in the levels of production resources in the two stocks. The flows in turn are defined by policies.

The flows into and out of the stocks represent ***material flows***, of say machines, that determine the production levels of a firm. The level of each stock at an instant in time represents the ***present conditions*** (or "initial" conditions at the present time). The three flows are defined by policies that are either explicit, as in the case of

resource acquisition, or implicit (in the "physics" of the system) as for the flows of resource assimilation and reduction.

The product of the effective production resources and the productivity of those resources is the production ***capability*** of the firm. Production capability is defined here as maximum production output. Increases in either productivity or production resources or both will increase production capability. Production capability can be defined in other ways also, and the formulation used here is made for sake of example only.

The stocks represent the ***state*** of the system, the flows into and out of the stocks represent the ***actions*** that change the state of a system over time. The flows are defined by the policies of the firm for the activity. The system modeled in Figure 3.3 is a dynamic system - as the state of the system (i.e. levels in each stock) change with time. If we freeze the system at a moment in time, the stocks show the ***asset*** position of the firm, the policies reveal the ***managerial choices*** in place, and the configuration of stocks and material and information flows show how the ***activity*** is presently performed in the firm. The snap-shot in time is the cross-sectional problem! If we unfreeze time, and let the system run on, we move into the realm of the longitudinal problem - seeing how positions evolve over time due to the interactions of assets, activities, and managerial choices.

The production resource accumulation activity discussed here is one of the many activities in a firm. How does it affect and get affected by the other activities in the firm? Porter has often advocated the importance of the ***linkages*** between activities. Now, we can operationalize the concept of linkages. We define linkages to be material and information flows between activities. 'Material' flows can be flows of money, orders, raw materials, personnel, and capital equipment -- almost anything can be modeled as a flow, if it flows! Information flows are used as inputs to decision-making. Policies define what information is used and how that information is converted into action. Every interrelationship, every linkage between all activities in a firm can be modeled using material and information flows. Once modeled, the nature of every interaction can be simulated over time. Simulation gives us the ability to see

how each activity changes with time, and how the interrelationships between activities (flows - material and information) change over time.

The activity of production resource accumulation is linked to other activities in a firm. Figure 3.4 shows a chart of organizational interrelationships for a firm. The model discussed above is part of the Production Resources sector.

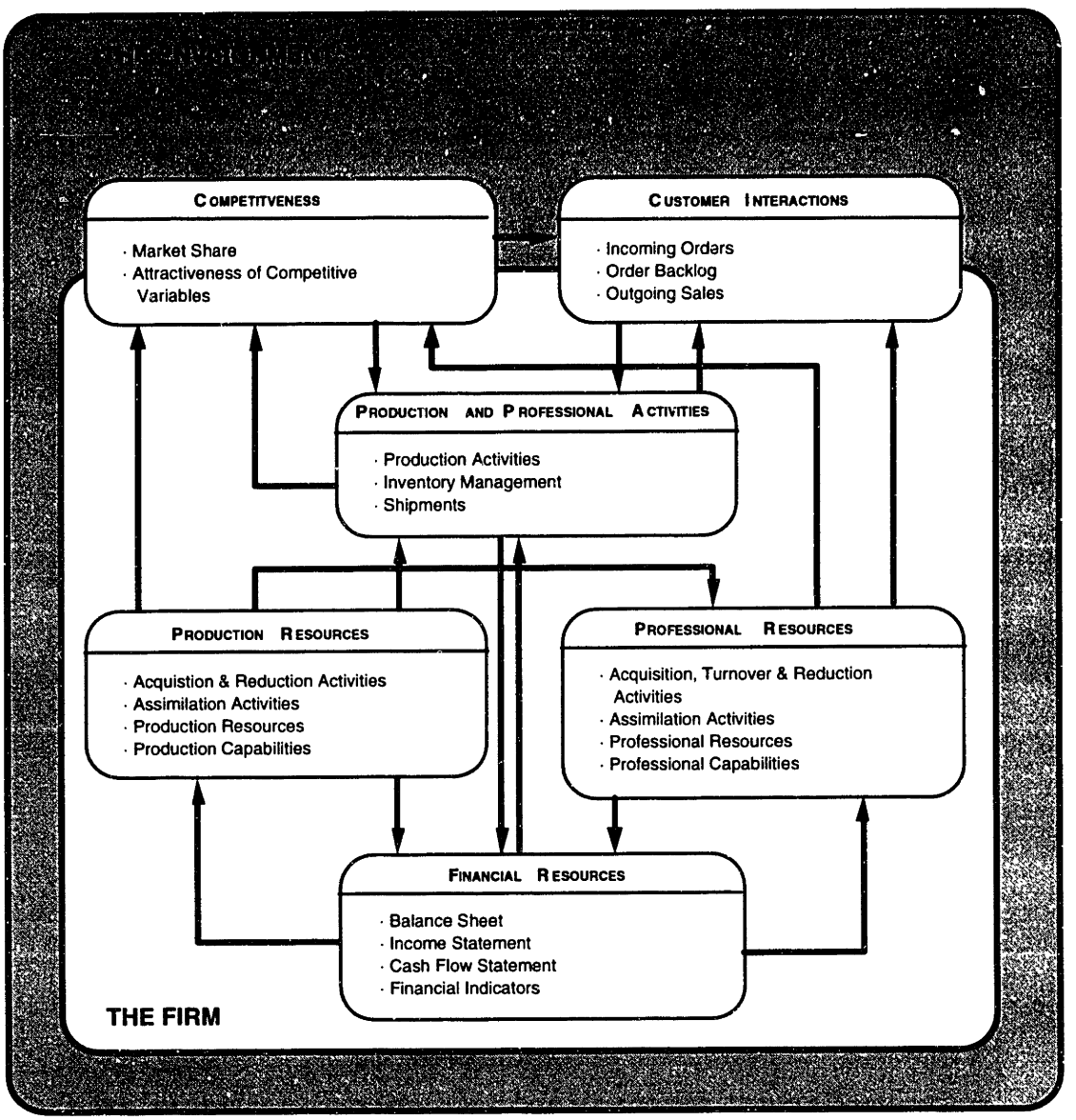


Figure 3.4 Interrelationships within a firm and with the environment

The arrows from the Production Resources sector represent the flows of material and information to and from the other sectors. The material and information flows represent linkages between activities, assets, and managerial choices in a firm.

For example, the production capabilities of a firm affects its competitiveness through the attractiveness of the firm's competitive variables like on-time-delivery. The accumulation of professional resources is linked to the acquisition of production resources - both are required in the right proportion to produce the goods and services of a firm. The acquisition of production resources is linked to the financials of the firm through the budgeting process which allocates the spending on production resources. The sectors of competitiveness and customer interactions represent the interface of the firm's internal system with the system of the external environment. The interactions of the firm with its environment ultimately defines success for the firm. (The linkages between production resources and the other sectors, and the whole model outlined in Figure 3.4 is presented in the Appendix.)

It is easy to see the power of the stocks and flows tool not only in allowing us to map explicitly the flows of material and information through the activities of the system, and the mutual interactions of assets, activities, and managerial choices on each other, but also in building models that can be simulated on a computer. Simulation allows experimentation with different policies, for example the policy for resource expansion, to understand the effect of decisions on the performance of the firm.

Simulation also offers the ability to re-configure the activities of a firm and re-define the linkages between activities. Policies can be redefined to use different inputs of information, and use them differently. System dynamics and simulation provide powerful tools to structurally *design* activities to achieve superior performance.

Also, the interrelationships between the firm and its environment can be modeled using information and material flows. For example, from the environment the firm receives material flows like orders, and information flows like competitive information. In return, the firm supplies a material flow of goods to the environment.

SKETCH OF THE INTEGRATIVE FRAMEWORK

Our example of resource accumulation showed the interactions of assets, activities, and managerial choices in a firm. These interactions are summarized in Figure 3.5 which is a schematic of the integrative theory of the firm. The theory is integrative because it integrates knowledge about assets (and the body of knowledge from the resource-based view of the firm), activities (positioning theory), and managerial choices (commitment theory, game theory) and maps the interactions between assets, activities, and choices using material and information flows (system dynamics). Success as defined by the integrative theory does not arise from a value chain; success comes from the interactions of a value *system*.

Compare Figure 3.5 with Porter's representation of the relation between the cross-sectional and the longitudinal problem. The cross-sectional problem is a snap-shot of the system at an instant in time. The longitudinal problem defines how the system evolves over time. Present conditions of a firm are defined by the current state of activities, assets, and managerial policies. Present conditions change as activities *accumulate* assets, and activities *influence* future managerial choices. Assets *constrain* the range of managerial choices possible, and *allow* the firm to perform activities. Managerial choices *configure* activities, and *acquire* assets to perform activities.

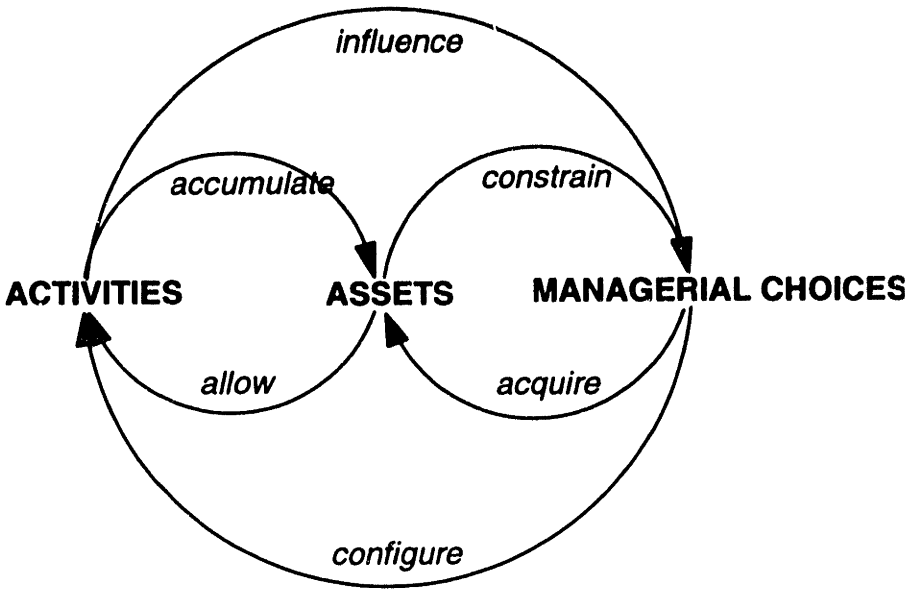


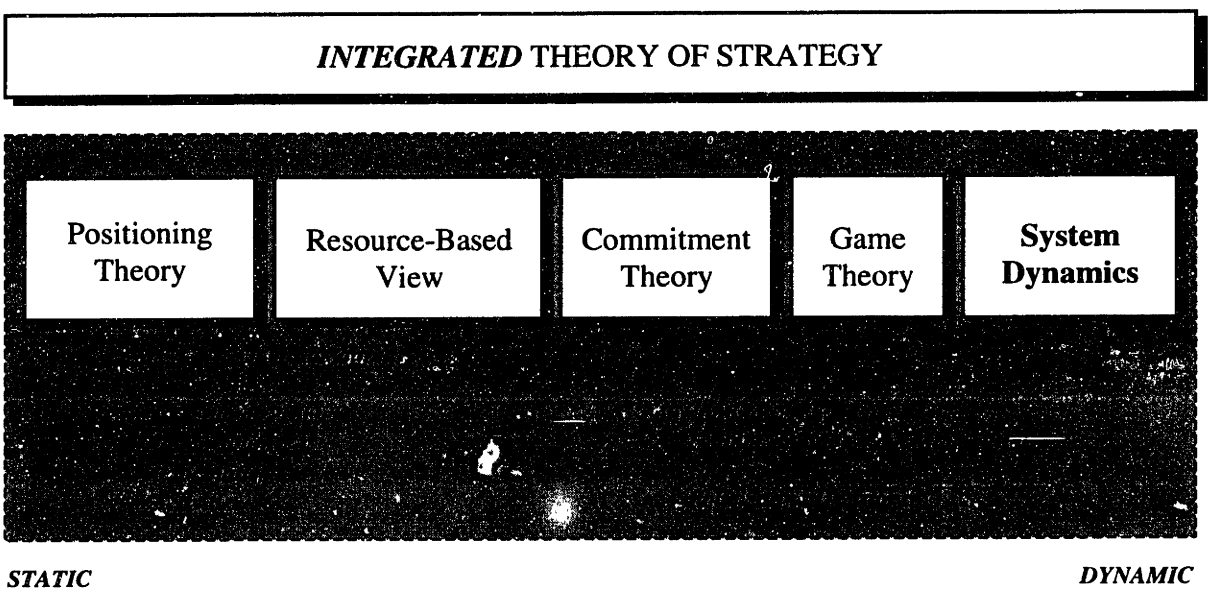
Figure 3.5 Systemic Determinants of Firm Success Internal to a Firm

Together the assets, activities, and choices in a firm interact through material and information flows to create capabilities for a firm. The capabilities of a firm create an attractiveness for the firm's products and services that when compared with the competition gives the firm a market position. The firm's market position and the industry attractiveness define success for the firm. Success in the cross-sectional problem arises from manages assets, activities, and choices in the longitudinal problem.

Porter's approach has been to decompose the theory of strategy into cross-sectional and longitudinal problems and to identify component theories that address each of the problems. While such an approach will help uncover deficiencies, it does little to integrate component theories and their knowledge into a common framework. Formulating and implementing strategy requires an integrated approach -- one that brings the best thinking from different disciplines together. In addition to the *analysis*

each component theory provides, the integration of these theories seeks to provide the *synthesis* of best practices from diverse disciplines to strategy.

Figure 3.6 shows the components of the integrated theory of strategy. The component theories range from the static to the dynamic end of the spectrum - but they are to be used together – with both models and frameworks – to inform the practice of strategic management.



Key Conceptual Issues

Before we evaluate the framework and the type of issues it allows us to explore, we highlight the salient features of the integrative framework. The key behind creating and sustaining competitive advantage is the creation of capabilities of the firm. The capabilities of the firm depended on three factors - activities, assets (i.e. leveraged resources), and managerial choices. Possessing assets allows a firm to perform activities, but the asset position of a firm also constrains its managerial choices. Activities influence the choices of a firm. Activities also cause the accumulation of assets like learning and knowledge. Managerial choices are made to acquire assets, and to configure activities in ways that will drive the creation of advantage.

A firm's capabilities are used to deliver products with attributes that the customer values, and to create new products. The former allows the firm to compete in the present markets, while the latter gives the firm a position in future markets. In the present, the attractiveness of a firm is responsible for the market share of the firm. Other forces external to the firm, like competition, customers, and characteristics particular to the industry interact with a firm's actions to create demand for the industry. The attractiveness of a firm results in the share of the market that the firm captures. The product of margin and sales volume gives profit of the firm. The success of the firm is the ability of the firm to maximize cumulative profits from its business activities.

EARLY BENCHMARKS

In this section, the dynamic component of the integrative framework is benchmarked against the challenges for a dynamic theory mentioned in the second chapter. The assessment is done to check if the integrative theory is meeting expectations at a conceptual level.

The integrative theory is complete in scope in that it deals with the firm and its environment. In an instance of the application of the integrative theory, the boundary or scope of the particular problem will need to be specified - the important issues are included within the boundary of the analysis. Exogenous changes, like technology and buyer needs for instance, can be accommodated by the integrative theory.

The use of system dynamics modeling and computer simulations provides the much needed tools that allow us to treat strategic actions concurrently. The role of timing in the simultaneous and continuous processes of competition is made explicit. The time horizon can be short or long term - but the emphasis is on maximizing cumulative profits over the long term. Trade-offs between short term performance and long term performance can be identified.

The chain of causality extends throughout all the functions of the firm and the environment. The integrative theory looks for the causal reasons behind the behavior

of firms. The emphasis of using the integrative theory to formulate strategy is in finding the high-leverage points in the business system and learning how to interact with the system by intervening at those points. The integrative theory aims at intervention with the system at the point of maximum benefit (at minimum cost). Rather than ascribe success to environmental factors that, at best, lie within the circle of concern to the firm, the focus is on finding leverage points that lie within the circle of influence of the firm and which can be controlled by the firm's policies.

Detail complexity is to be addressed through the use of frameworks and dynamic complexity is addressed through the use of computer modeling. The use of computers enhances the cognitive abilities of the human decision maker in understanding the non-linear dynamics of competition.

The need for empirical validity is addressed by measuring the utility of the integrative framework and dynamic modeling in aiding an understanding of business problems and in finding specific solutions to the problems. Rather than relying solely on the use of statistical testing, the use of mental models (that contain much more than just measurable data) and case-studies has provided alternative routes to measuring validity.

The integrative theory has been discussed on a conceptual level so far with the possible exception of the stylized example of production resource accumulation. Future research should be aimed at providing a library of explicit formulations for the issues in strategy. The next chapter makes the first few steps by proposing the design of a system dynamics model of the theory. The model begins to operationalize competitive advantage in terms of the assets, activities, and managerial choices of the firm.

Research on the Integrated Theory

The previous three chapters have presented the motivation for research in the dynamics of competitive strategy, discussed how the cross-sectional problem needed to be combined with the longitudinal problem to create an integrated theory of strategy, and sketched the outlines for a conceptual framework for the integrated theory. The integrated theory promises many new insights into the true origins of competitive success, but these insights have not yet been translated into practical concepts that managers can use in making decisions. Future research will take the conceptual framework of the integrative theory, and through the development of models (like the one in this chapter) that study the problems of businesses, system dynamics modeling will develop management principles that operationalize the framework by putting it into the context of specific problems of interest to firms and industries.

The tools of system dynamics can be used to model and understand problems facing any firm in any industry. Models are built to study specific problems in systems - not map the entire structure of systems. Generic models are stylized models that map particular parts of a system's structure to explore the issues of interest. Such models are 'generic' if the problems they study are observed "generically" across several firms and industries. Examples of such models are Forrester's production-distribution model and the market-growth model. While such models are powerful in that they

provide insights and management principles that are applicable to several firms, generic models are not to be confused with models built for a particular company to study a particular problem. Such industry-specific, firm-specific models reflect the system at work in a particular company. It is the design of such specific models that needs to be undertaken to understand the performance of the particular firm, rather than just apply the insights generated from "generic" studies of firms. Forrester argues that it is the design of such business systems that should be the primary responsibility of the CEO of a company.

Management gurus, on the other hand, usually respond to the challenge of achieving superior performance in one of two ways - either proposing "questions that every manager must ask" or by suggesting the fad of the year—be it TQM or BPR or something else. Both ways are insufficient. Much of today's management literature is focused on asking the right questions - with the assumption that if the attention of top management is directed in the 'right' direction, it will arrive at the 'right' answers. The performance of many companies has proven otherwise. Although asking the 'right' questions has helped find the right levers, poor performance has often been the result of the right levers being pushed in the wrong direction, or at the wrong time, or with the wrong magnitude of force. Adopting the fad of the year is equally unlikely to create market leadership. For several firms, receiving the Baldridge award has often been closely followed by employee lay-offs and falling stock prices.[22] Successful re-engineering programs that drastically reduce cycle time and increase productivity often have very little impact on the overall financial performance of the firm.

Choices recommended without attention to the particular situation are usually the wrong ones. There are three reasons why this is so - leverage points shift over time, the amount each lever should be pushed changes with time, and the right time to push a lever also depends on the particular situation. We take an intermediate route between suggesting questions to ask and suggesting blanket programs like TQM as the panacea to all business problems. This intermediate route involves two thrusts. First,

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[22] See Sterman (1995) for an exploration of the unanticipated side-effects of a successful quality program at Analog Devices.

we should search for patterns of commitments to activities and resource accumulation that characterize superior performers. The interest here is on finding patterns of choices that reinforce each other to drive the creation of advantage. The idea here is to set in motion chain reactions that create energy rather than consume it. Second, we should investigate the causes of inferior performance and failure across firms and industries. The effort here is to examine the problematic syndromes—corporate problems that occur frequently—that companies suffer from. Since these problems are independent of any particular firm or industry, we focus our attention not on the particular management team or their decisions but on the systemic reasons for failures. These two thrusts provide important areas for research on the integrated theory of strategy. In both cases, the focus of the research is on discovering *systemic* reasons for success and failure of firms across industries and not accidental causes for the success or failure of any particular firm.

Towards this end, a system dynamics model is being developed as an experimental formulation of the integrated theory. The computer simulations of the model will be used to relate to the observed performance of companies as measured through documented case-studies of firms. Furthermore, the implications of the policy structure of the firm on its behavior will be made explicit. The results and insights obtained from the model will eventually be used to develop management principles to guide the formulation, implementation, and evaluation of strategy.

THE MODEL

Overview

The firm's activities are modeled to study the dynamics created by the activities of the firm and their impact on the firm's success. The model does not represent a particular firm, but rather explores the dynamics of the interactions between the activities of a hypothetical firm. The structure of the model, therefore, represents a hypothesis, and uses several assumptions, like the time delays for management response and market response, that are representative of real companies.

The model seeks to understand the interactions of potential demand for the firm's products and services, the order rate the firm faces, and the firm's ability to fill orders through its production and professional capabilities. From a strategic perspective, of crucial importance to the firm is the ability to acquire and develop these production and professional resources into capabilities that will build and sustain the firm's competitive advantage in the market. Towards this end, the model studies the acquisition of production and professional resources, the allocation of these resources towards the creation of customer value, the market position that arises from the attractiveness of the firm's products and services relative to the competition, and the effect of market position on sales. Particular attention is also given to the resource constraints that the firm faces, and the firm's ability to manage around these constraints.

We have maintained that the configuration of activities and the timing of these activities drives the performance of the firm. Both the configuration and the timing of activities is a direct result of the managerial decisions made in the firm. These managerial decisions are made in the context of the available resources of the firm and the information available to the manager at that time. This indicates the need to focus our efforts on three critical factors - the decision rules or policies that managers use, the firm's resource position and the capabilities they represent, and the information available to the decision-maker. The model focuses on these three factors by studying the interactions between the flows of orders, materials, personnel, capital equipment, sales, money, and information, and the resulting accumulations of resources that give the firm its capabilities to acquire and sustain competitive advantage.

Hypothesis

Typically, the formulation of a system dynamics model requires a hypothesis that attempts to explain the relation between the structure of the system being studied and it's behavior. The outline of the integrated theory we have discussed in the previous chapter provides the hypothesis for our model. Here are some of the salient features of this hypothesis.

The firm uses internal and external sources of financial capital to obtain the production and professional resources it needs to invest in growth. Depending on the strategy of the firm, resource allocations are made by giving higher priority to certain activities of the firm over others. The resource position of the firm emerges with certain resources coming on-line before others. This developing resource position represents a commitment on the part of the firm to the strategy it has chosen. The resource position of the firm can be leveraged to increase its resourcefulness. The effective levels of resources that a firm possesses and the ability of the firm to leverage those resources determines the capabilities of the firm. The ability to get products to market first and insure the availability of the product in times of rising demand are two examples of capabilities of the firm. The capabilities of the firm and the price it charges are together responsible for the attractiveness of the firm's products and services.

Market share is determined by the relative attractiveness of a firm's products and services with respect to the competition. The market share of a firm and the total potential demand in the industry are responsible for the volume of incoming orders to the firm. The firm's ability to meet incoming orders determines the outgoing shipments that the firm can make. The difference between the price and cost of the sales volume is the firm's profit. The firm's profit is taxed, dividends and interest payments are made and we are left with possible internal sources of financial capital.

In the short term the firm competes on price/performance characteristics of its product. In the long term the firm competes on its ability to develop new products and markets.

Structure

The model includes sectors for production resources, professional resources, production and professional activities, the financials (balance sheet, income statement, cash flow statement), customer interactions, and competitiveness.[23]

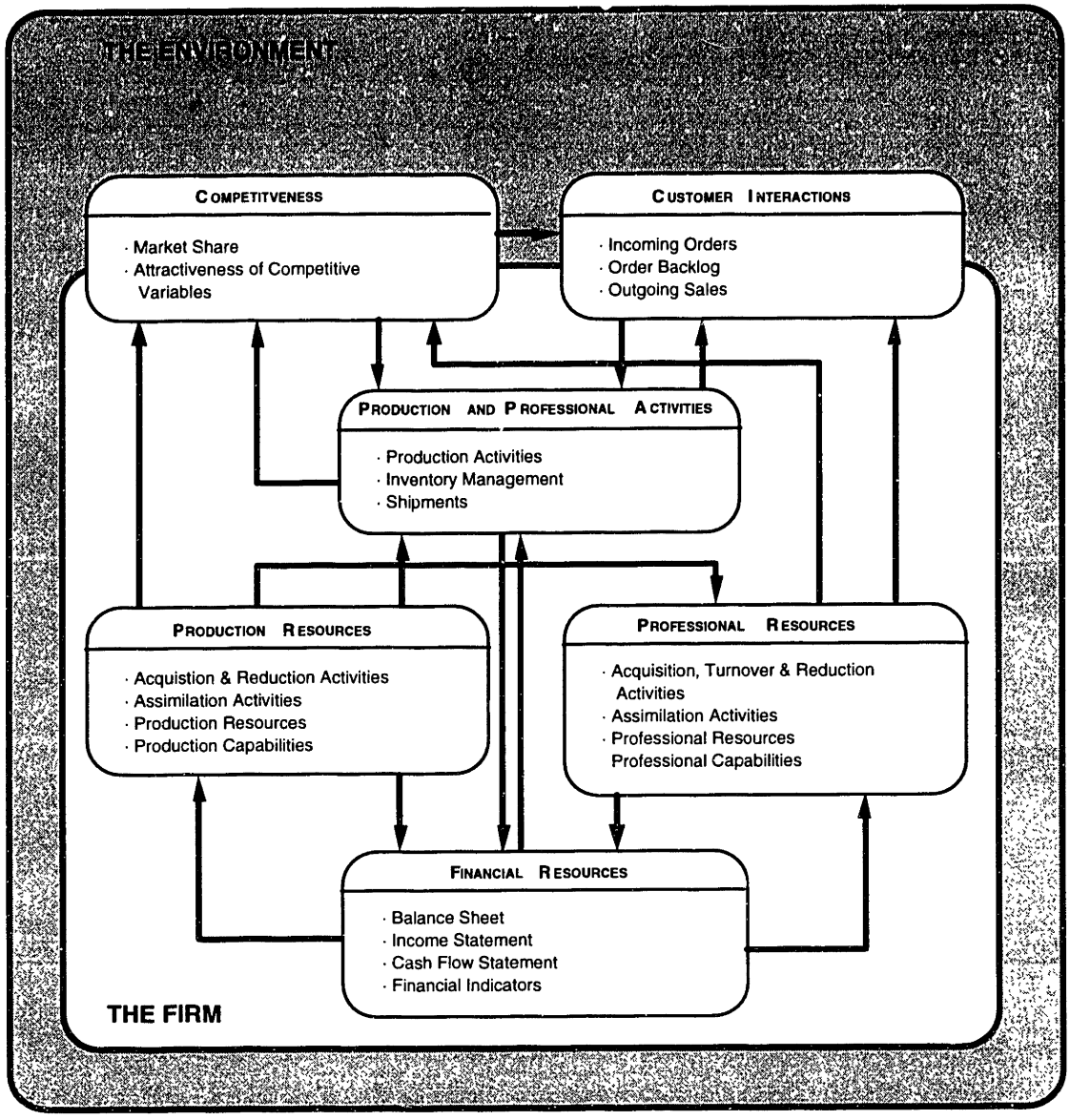

Figure 4.1 Model Structure: The primary subsystems

[23] The equations for the structure presented are in the Appendix. The complete model documentation can be obtained from the author through the MIT System Dynamics Group, Sloan School of Management.

Figure 4.1 shows the major sectors of the model and the linkages between them. The firm is shown embedded within the larger environment. Notice that the sectors *Competitiveness* and *Customer Interactions* cross the boundary between the firm and its environment. These sectors capture the dynamic interactions between the firm and its competitors and customers.

The future use of the model will be to explore different problem modes experienced by companies. These problem modes represent frequently occurring corporate problems, and are drawn from the literature on competitive strategy and system dynamics. The purpose of these explorations is to formulate hypotheses about the cause and effect relations that underlie the problem modes, to understand how the activities of the firm are responsible for the performance of the firm over time, to learn to recognize the symptoms of some frequent problem modes, and how to design preventive policies that avoid these corporate problems.

The new tools of system dynamics and simulation hold much promise for the field of strategy. The challenge for managers is to learn how to best use these tools, how to incorporate them into their present arsenal of tools for strategic management, and eventually how to use these tools to enhance management intuition. The tools of system dynamics are sophisticated and powerful, and they require a commitment to learning. Surely, the challenges are great. So are the rewards.

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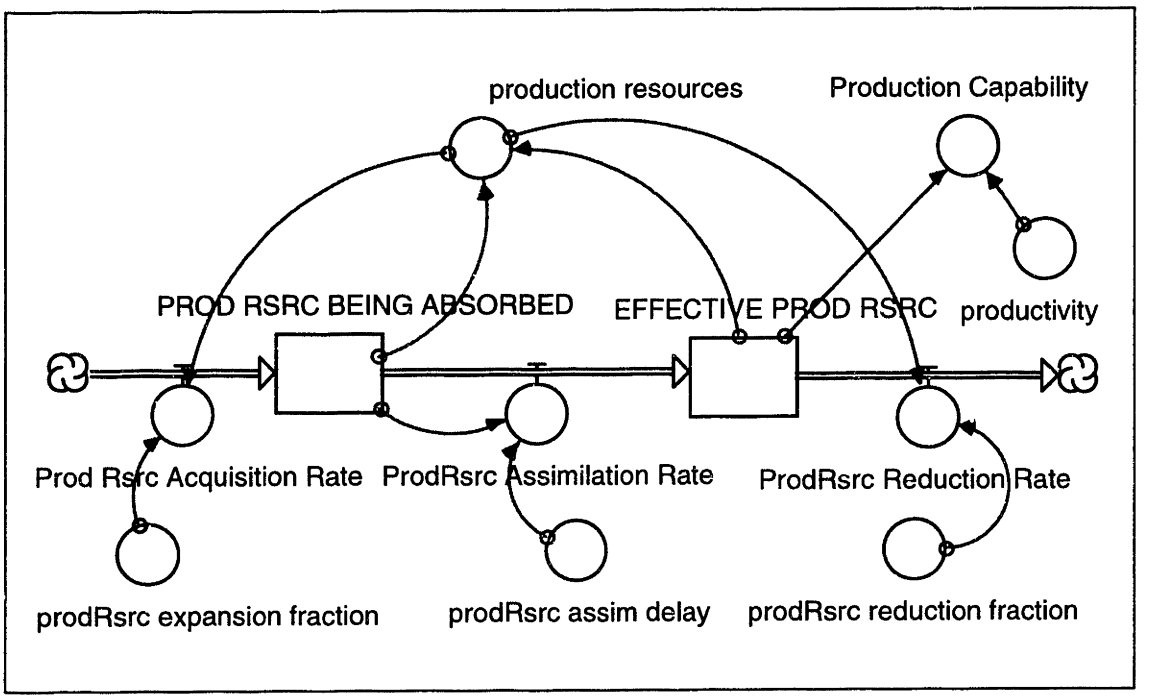
Appendix

PRODUCTION RESOURCES

Diagram



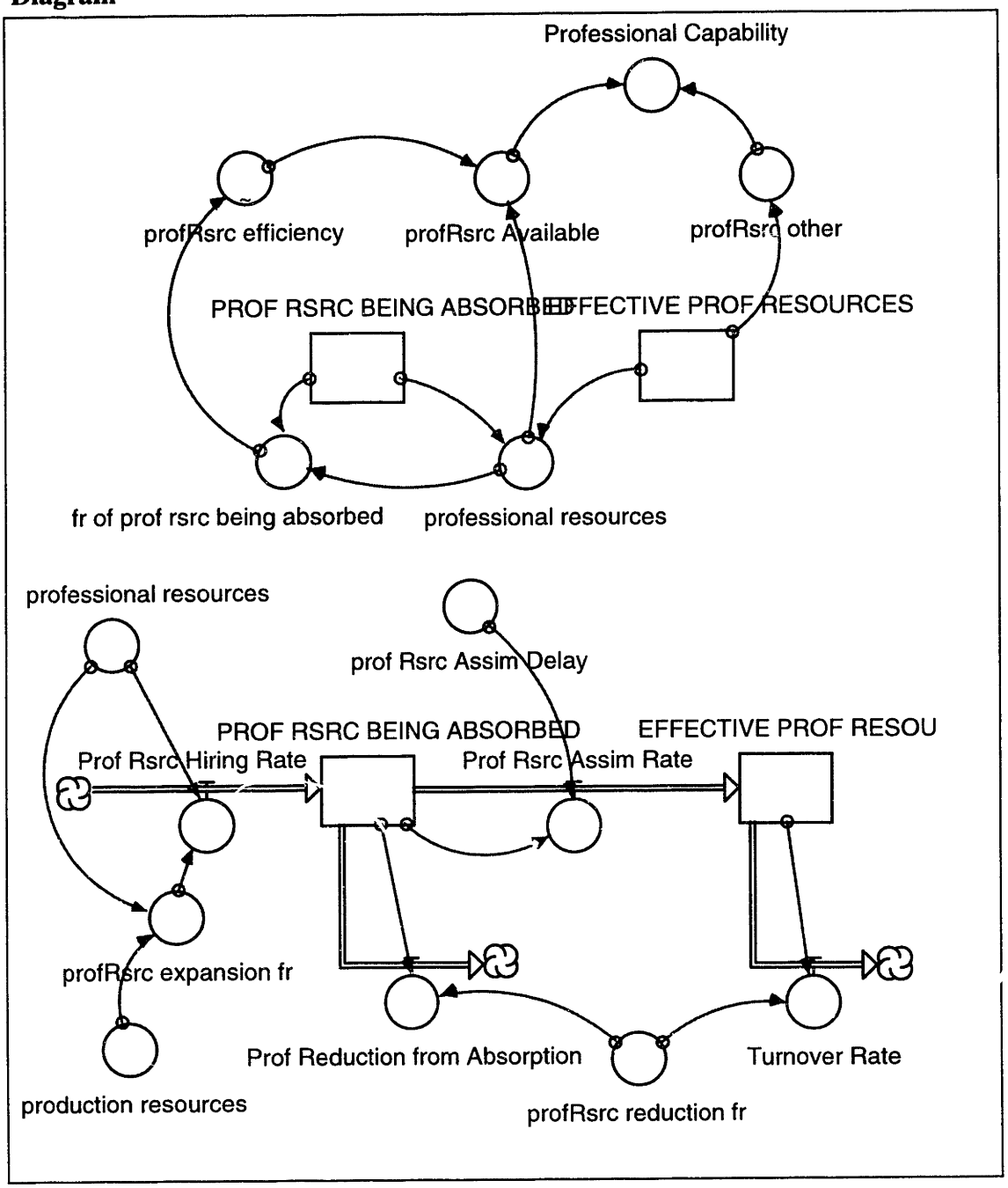
Equations

```
EFFECTIVE_PROD_RSRC(t) = EFFECTIVE_PROD_RSRC(t - dt) +
(ProdRsrc_Assimilation_Rate - ProdRsrc_Reduction_Rate) * dt
ProdRsrc_Assimilation_Rate =
PROD_RSRC_BEING_ABSORBED/prodRsrc_assim_delay
ProdRsrc_Reduction_Rate =
production_resources*prodRsrc_reduction_fraction
PROD_RSRC_BEING_ABSORBED(t) = PROD_RSRC_BEING_ABSORBED(t - dt) +
(Prod_Rsrc_Acquisition_Rate - ProdRsrc_Assimilation_Rate) * dt
INIT PROD_RSRC_BEING_ABSORBED =
(EFFECTIVE_PROD_RSRC*prodRsrc_expansion_fraction*prodRsrc_assim_delay
)/(1-prodRsrc_expansion_fraction*prodRsrc_assim_delay)
Prod_Rsrc_Acquisition_Rate =
production_resources*prodRsrc_expansion_fraction
ProdRsrc_Assimilation_Rate =
PROD_RSRC_BEING_ABSORBED/prodRsrc_assim_delay
Production_Capability = EFFECTIVE_PROD_RSRC*productivity
production_resources = EFFECTIVE_PROD_RSRC+PROD_RSRC_BEING_ABSORBED
```

productivity, prodRsrc_assim_delay, prodRsrc_expansion_fraction, and prodRsrc_reduction_fraction are parameters.

PROFESSIONAL RESOURCES

Diagram



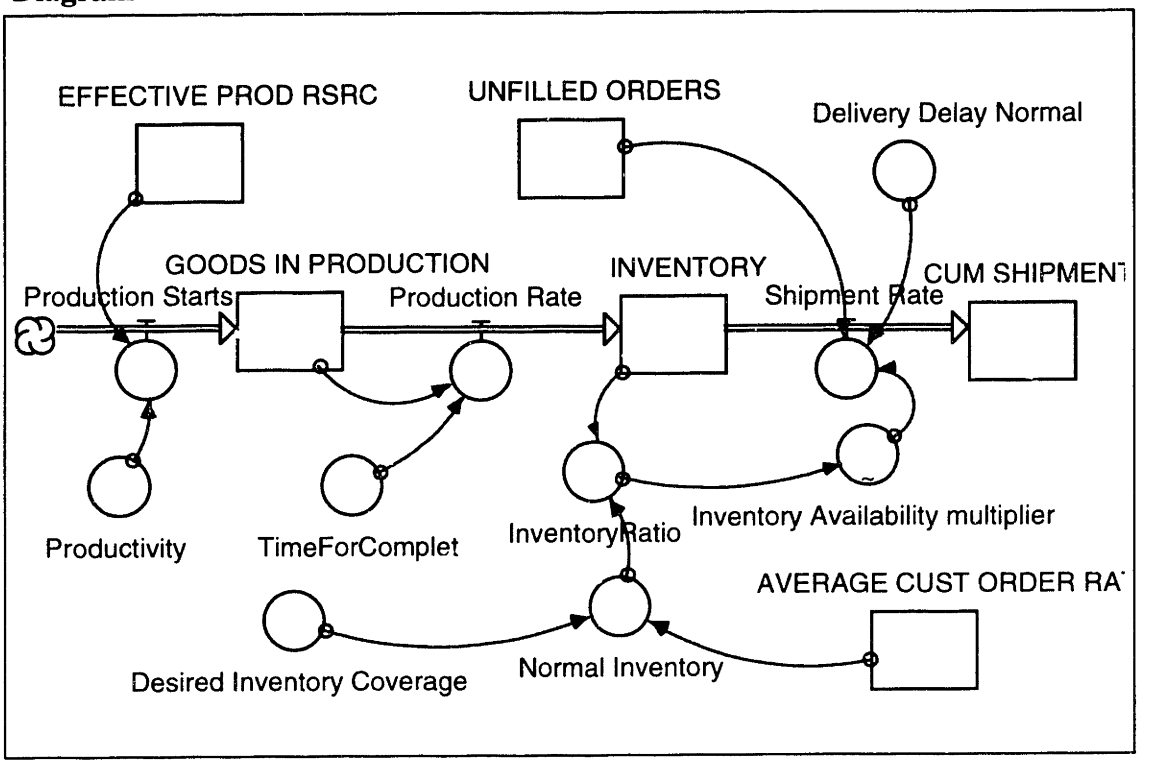
Equations

```
EFFECTIVE_PROF_RESOURCES(t) = EFFECTIVE_PROF_RESOURCES(t - dt) +
(Prof_Rsrc_Assim_Rate - Turnover_Rate) * dt
Prof_Rsrc_Assim_Rate = PROF_RSRC_BEING_ABSORBED/prof_Rsrc_Assim_Delay
Turnover_Rate = EFFECTIVE_PROF_RESOURCES*profRsrc_reduction_fr
```

```
PROF_RSRC_BEING_ABSORBED(t) = PROF_RSRC_BEING_ABSORBED(t - dt) +
(Prof_Rsrc_Hiring_Rate - Prof_Rsrc_Assim_Rate -
Prof_Reduction_from_Absorption) * dt
Prof_Rsrc_Hiring_Rate = professional_resources*profRsrc_expansion_fr
Prof_Rsrc_Assim_Rate = PROF_RSRC_BEING_ABSORBED/prof_Rsrc_Assim_Delay
Prof_Reduction_from_Absorption =
PROF_RSRC_BEING_ABSORBED*profRsrc_reduction_fr
fr_of_prof_rsrc_being_absorbed =
PROF_RSRC_BEING_ABSORBED/professional_resources
Professional_Capability = profRsrc_Available - profRsrc_other
professional_resources = EFFECTIVE_PROF_RESOURCES +
PROF_RSRC_BEING_ABSORBED
profRsrc_Available = professional_resources*profRsrc_efficiency
profRsrc_expansion_fr = professional_resources/production_resources
profRsrc_other = EFFECTIVE_PROF_RESOURCES
profRsrc_reduction_fr, prof_Rsrc_Assim_Delay, profRsrc_efficiency =
GRAPH(fr_of_prof_rsrc_being_absorbed) are parameters.
```

PRODUCTION ACTIVITIES

Diagram



Equations

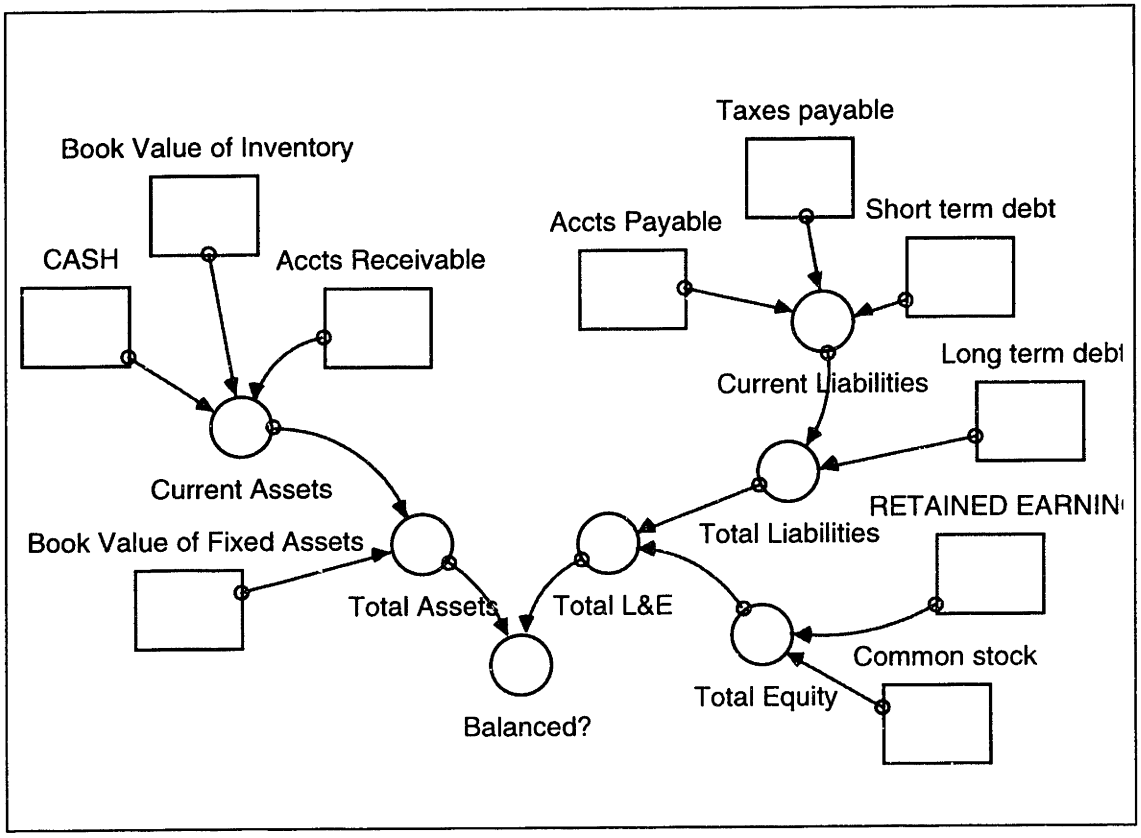
```
AVERAGE_CUST_ORDER_RATE(t) = AVERAGE_CUST_ORDER_RATE(t - dt) +
(Change_in_Expected_Order_Rate) * dt
CUM_SHIPMENTS(t) = CUM_SHIPMENTS(t - dt) + (Shipment_Rate) * dt
Shipment_Rate = (UNFILLED_ORDERS / Delivery_Delay_Normal) *
Inventory_Availability_multiplier
EFFECTIVE_PROD_RSRC(t) = EFFECTIVE_PROD_RSRC(t - dt)
GOODS_IN_PRODUCTION(t) = GOODS_IN_PRODUCTION(t - dt) +
(Production_Starts - Production_Rate) * dt
Production_Starts = EFFECTIVE_PROD_RSRC * Productivity
Production_Rate = GOODS_IN_PRODUCTION / TimeForComplet
INVENTORY(t) = INVENTORY(t-dt) + (Production_Rate-Shipment_Rate)*dt
Production_Rate = GOODS_IN_PRODUCTION / TimeForComplet
Shipment_Rate = (UNFILLED_ORDERS / Delivery_Delay_Normal) *
Inventory_Availability_multiplier
UNFILLED_ORDERS(t) = UNFILLED_ORDERS(t - dt)
InventoryRatio = INVENTORY / Normal_Inventory
Normal_Inventory = AVERAGE_CUST_ORDER_RATE *
Desired_Inventory_Coverage
desired_inventory = AVERAGE_CUST_ORDER_RATE*normal_inventory_coverage
```

```
Productivity, TimeForComplet, Inventory_Availability_multiplier =
GRAPH(InventoryRatio), Desired_Inventory_Coverage,
Delivery_Delay_Normal are parameters.
```

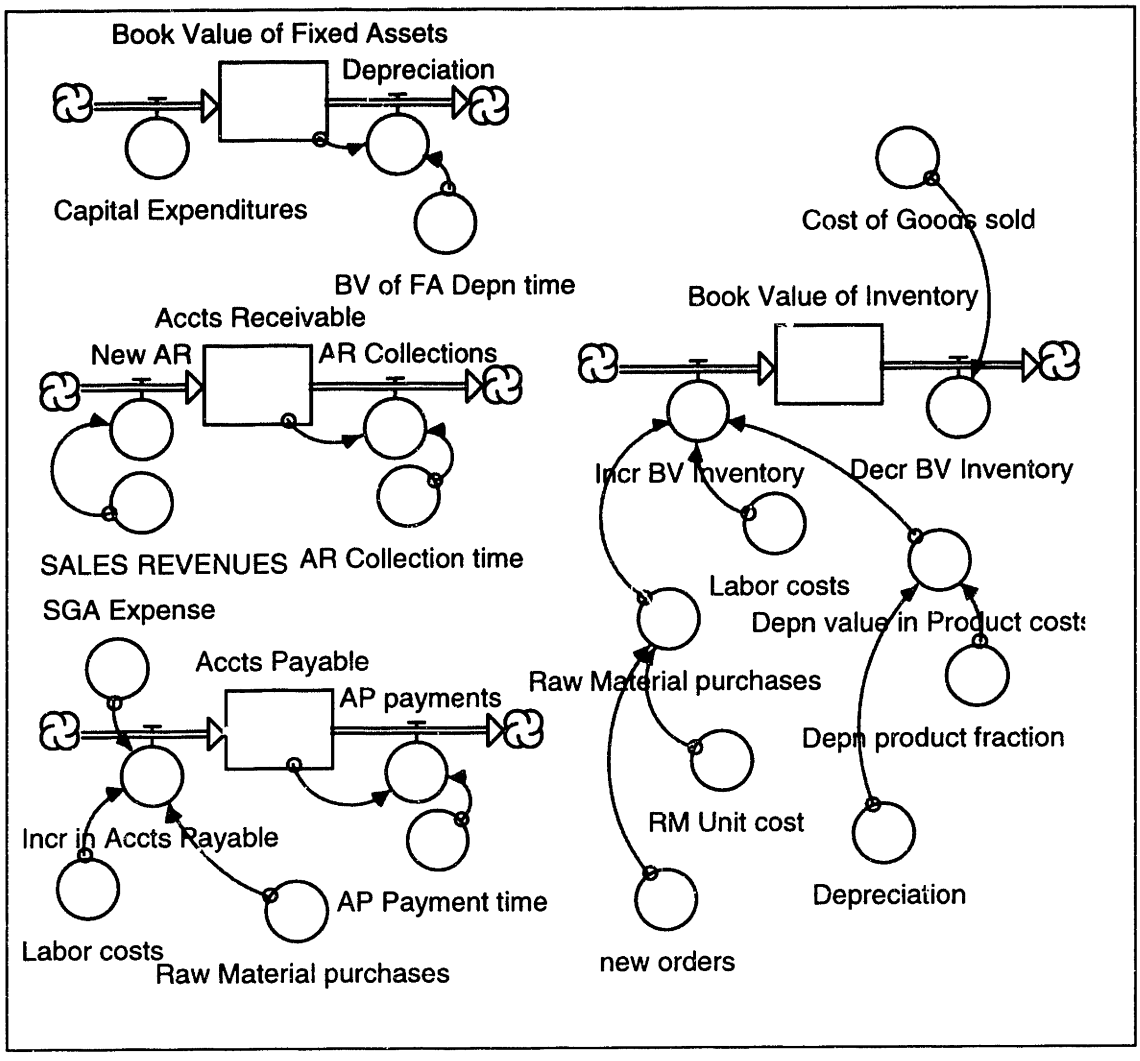
THE FINANCIALS

The balance sheet, cash flow statement, and the income statement were prepared using generally accepted accounting principles.[24] Since the values of financial variables are firm specific, and the accounting identities used are well-known, we have not presented the equations for the financials sector.

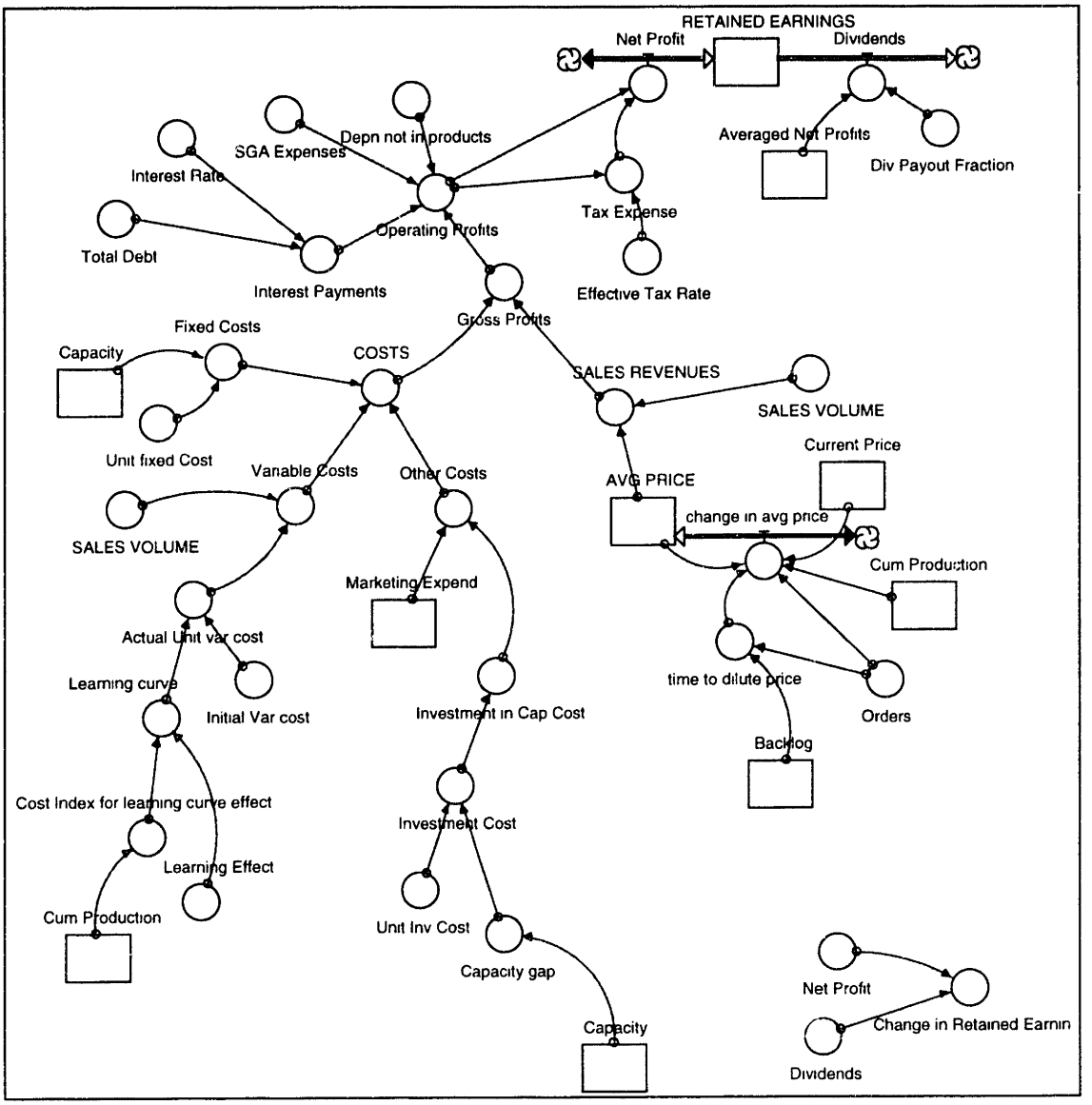
Balance Sheet



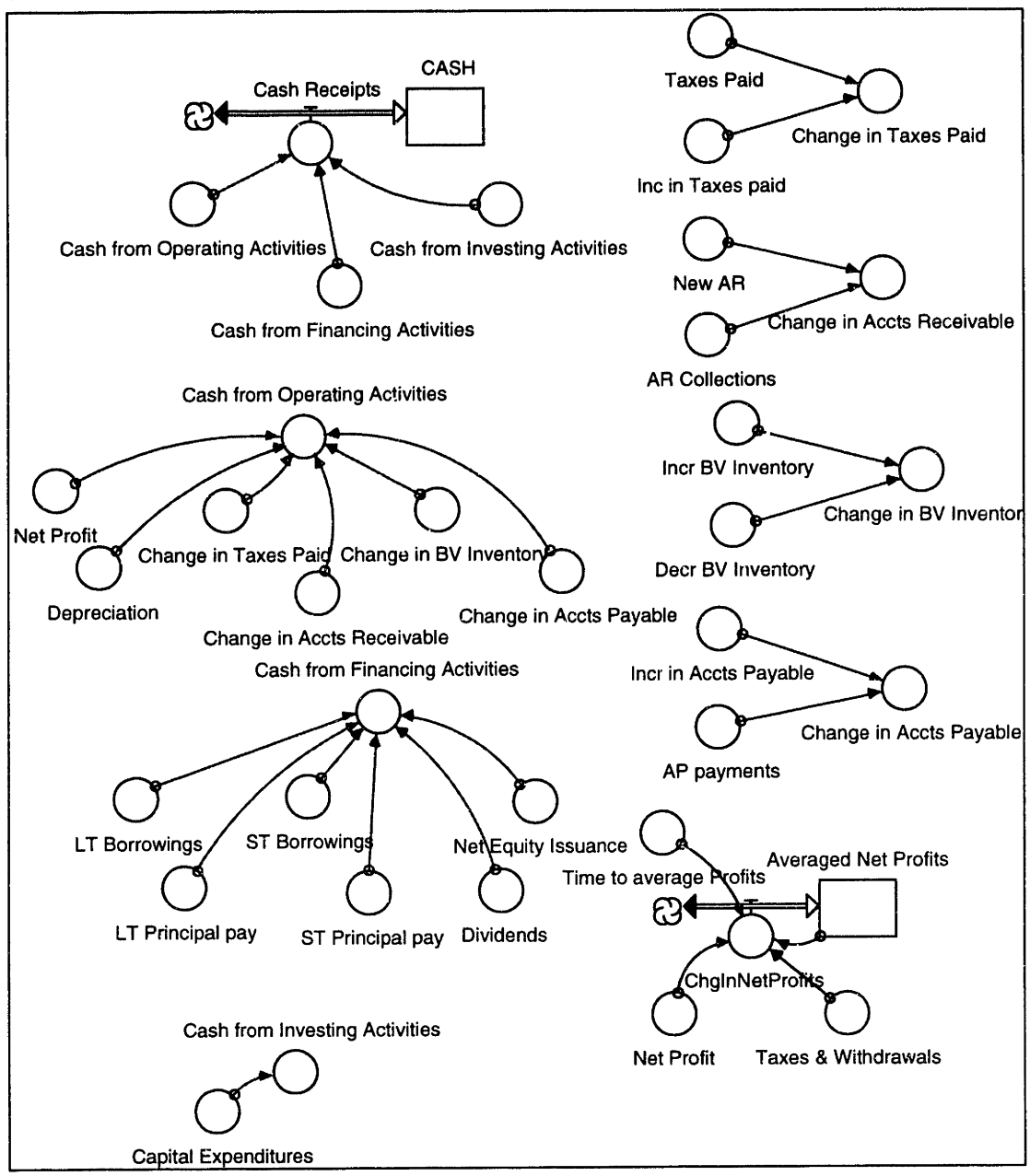
[24] For an understanding of the accounting equations, please see an introductory text in accounting.

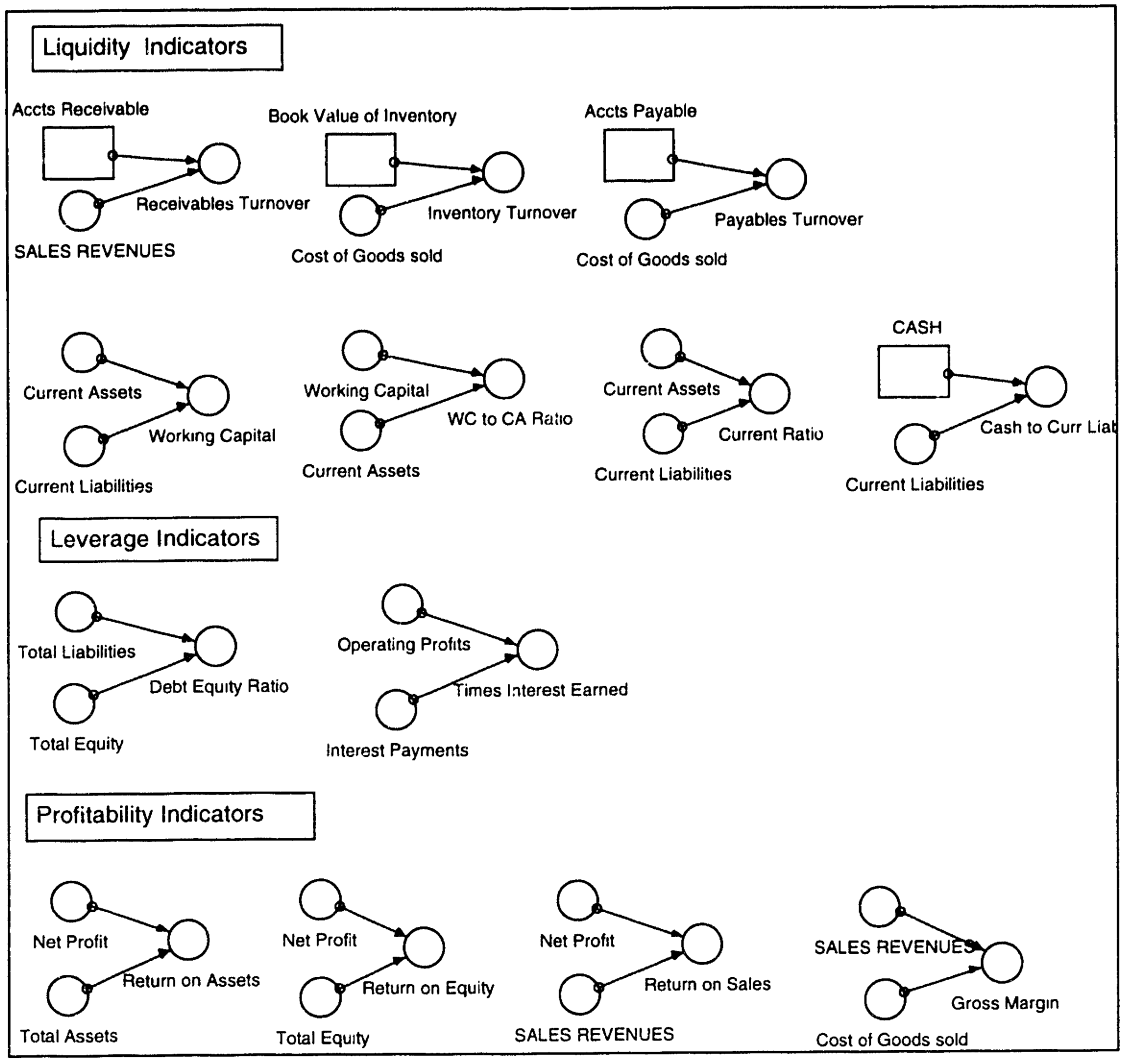

Book Value of Fixed Assets
Depreciation
Capital Expenditures
BV of FA Depn time
Accts Receivable
New AR
AR Collections
SALES REVENUES
AR Collection time
SGA Expense
Accts Payable
AP payments
Incr in Accts Rayable
AP Payment time
Labor costs
Raw Material purchases
Cost of Goods sold
Book Value of Inventory
Incr BV Inventory
Decr BV Inventory
Labor costs
Depn value in Product costs
Raw Material purchases
Depn product fraction
RM Unit cost
Depreciation
new orders

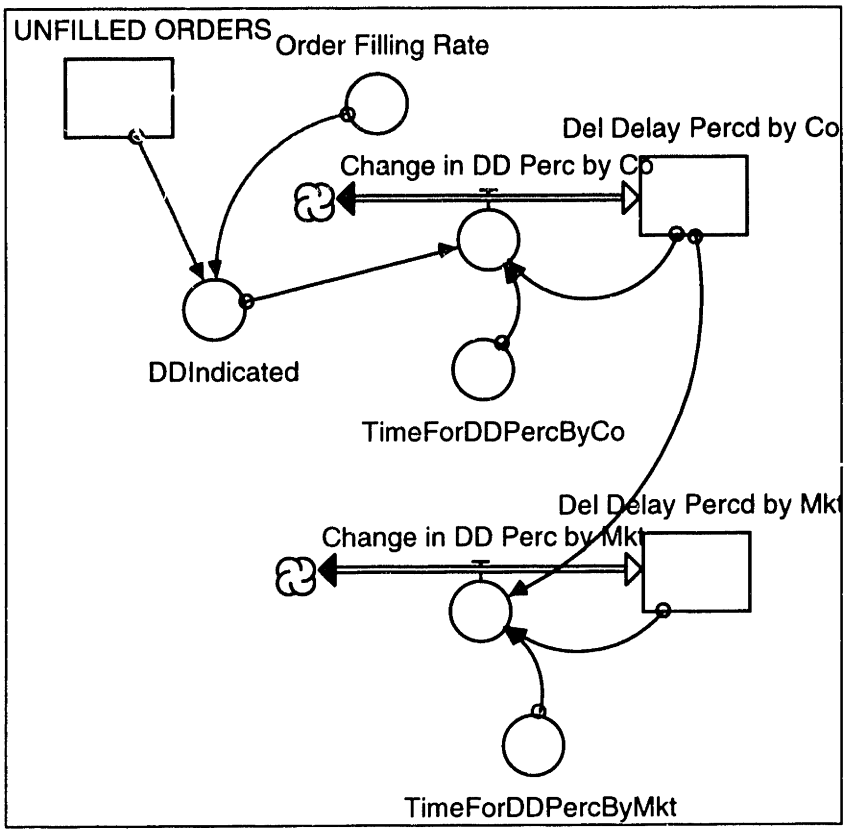
Income Statement



Cash Flow Statement

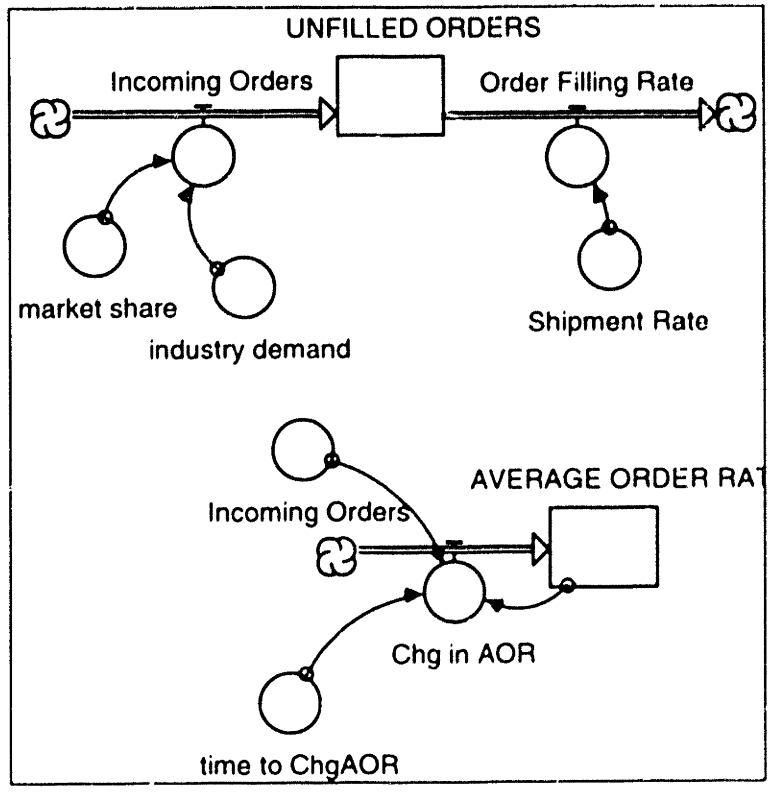



Liquidity Indicators
Accts Receivable
Receivables Turnover
SALES REVENUES
Book Value of Inventory
Inventory Turnover
Cost of Goods sold
Accts Payable
Payables Turnover
Cost of Goods sold
Current Assets
Working Capital
Current Liabilities
Working Capital
WC to CA Ratio
Current Assets
Current Assets
Current Ratio
Current Liabilities
CASH
Cash to Curr Liab
Current Liabilities
Leverage Indicators
Total Liabilities
Debt Equity Ratio
Total Equity
Operating Profits
Times Interest Earned
Interest Payments
Profitability Indicators
Net Profit
Return on Assets
Total Assets
Net Profit
Return on Equity
Total Equity
Net Profit
Return on Sales
SALES REVENUES
SALES REVENUES
Gross Margin
Cost of Goods sold


UNFILLED ORDERS
Order Filling Rate
Del Delay Percd by Co
Change in DD Perc by Co
DDIndicated
TimeForDDPercByCo
Del Delay Percd by Mkt
Change in DD Perc by Mkt
TimeForDDPercByMkt

CUSTOMER INTERACTIONS

Diagram



Equations

```
AVERAGE_ORDER_RATE(t) = AVERAGE_ORDER_RATE(t - dt) + (Chg_in_AOR) * dt
INIT AVERAGE_ORDER_RATE = Order_Filling_Rate
Chg_in_AOR = (Incoming_Orders-AVERAGE_ORDER_RATE)/time_to_ChgAOR
UNFILLED_ORDERS(t) = UNFILLED_ORDERS(t - dt) + (Incoming_Orders
Order_Filling_Rate) * dt
Incoming_Orders = industry_demand*market_share
Order_Filling_Rate = Shipment_Rate
industry_demand = from industry
market_share = from_COMPETITIVENESS_sector
Shipment_Rate = from_PROD_ACTIVITIES_sector
time_to_ChgAOR is a parameter.
```

COMPETITIVENESS

Equations

```
TRADITIONAL_MKT_SHARE(t) = TRADITIONAL_MKT_SHARE(t - dt) +
(ChangeinTMS) * dt

ChangeinTMS = MARKET_SHARE_gained/Time_to_developTMS

AdvertBud = RefAdvertBud*(1+STEP(FrChangeInAdvertBud,
TimeToChangeAdvertBud))

AdvertRatio = AdvertBud/RefAdvertBud

Effect_of_Attractiveness_of_Competitive_Variables =
TotalAttrFromAdvert*TotalAttrFromAvailability*TotalAttrFromPrice*Tota
lAttrFromQuality*TotalAttrFromService*TotalAttrFromTechDiff

MARKET_SHARE_gained = TRADITIONAL_MKT_SHARE *
Effect_of_Attractiveness_of_Competitive_Variables

PriceRatio = ProdPrice/RefPrice

ProdPrice = RefPrice*(1+STEP(FrChangeInPrice, TimeToChangePrice))

ProdQuality = RefQuality*(1+STEP(FrChangeInQuality,
TimeToChangeQuality))

QualityRatio = ProdQuality/RefQuality

TotalAttrFromAdvert = ProdAttrFromAdvert*WtForImportOfAdvert

TotalAttrFromAvailability =
ProdAttrFromAvailability*WeightForImportOfAvailability

TotalAttrFromPrice = ProdAttrFromPrice*WtForImportOfPrice

TotalAttrFromQuality = ProdAttrFromQuality*WtForImportOfPrice_2

TotalAttrFromService = ProdAttrFromService*WeightForImportOfService

TotalAttrFromTechDiff =
ProdAttrFromTechDiff\ProductNewness*WtForImportOfTechDiff

ProdAttrFromAdvert = GRAPH(AdvertRatio)

ProdAttrFromAvailability = GRAPH(Del_Delay_Percd_by_Mkt)

ProdAttrFromPrice = GRAPH(PriceRatio)

ProdAttrFromQuality = GRAPH(QualityRatio)
```

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