SUPPLY CHAIN MANAGEMENT KNOWLEDGE AND ORGANIZATIONAL STRUCTURE

BY

WILLIAM JAMES CHRISTENSEN

Bachelor of Arts
California State University
Hayward, California
1978

Master of Business Administration
California State University
Hayward, California
1981

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
May, 2000

SUPPLY CHAIN MANAGEMENT KNOWLEDGE

AND ORGANIZATIONAL STRUCTURE

Thesis Approved:

Richard Germain

Thesis Advisor

Margaret A. White

Gary Frankwick

Ruth H. Krieger

Wayne B. Powell

Dean of the Graduate College

ACKNOWLEDGEMENTS

I wish to express my appreciation to Dr. Richard Germain for his kindness and patience in guiding me through this project. His mentoring instilled in me a desire to pursue a life-path of knowledge and research.

I also want to recognize the significant and valued contributions of each of my committee members: Dr. Ruth Kreiger, Dr. Gary Frankwick, and Dr. Margaret White. Many thanks to each of them. I also express thanks to the many other faculty and fellow doctoral students, including those at Michigan State University, whose friendship, support, and encouragement have helped me on my way.

I wish to express my appreciation to the companies that have provided me with the "real-world" experience that has been so helpful in my academic pursuits. Thanks to Mr. Sang Soo Lee, formerly of POSCO Steel in Korea, for his friendship and encouragement. My gratitude also extends to the National Association of Purchasing Management (NAPM) for their generous grant.

I express my love and gratitude to my parents, brother, and sisters, all of whom have provided constant encouragement and support. Finally, and most importantly, I express my deepest love and heartfelt thanks to my wife, Robin. Through over ten years of doctoral education, she has always been loving, kind, and patient. Also, to my children Benjamin and Alexandria, for their support and patience, I express my sincerest love and gratitude.

TABLE OF CONTENTS

Chapter | Page

II. LITERATURE REVIEW (continued)

LIST OF TABLES

Table Page

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Increasingly, business environments are defined by the seemingly endless growth in technology and knowledge. This is evidenced by the fact that Knowledge Management (KM) is considered "absolutely critical to the success of my company" by 60 percent of the CEO's responding to a 1998 survey conducted jointly by the World Economic Forum and Pricewaterhouse Coopers (Havens and Knapp 1999). As Bell (1973) predicted, in today's postindustrial society, knowledge and information are replacing capital and energy as the primary wealth-creating assets. In Europe it is expected that corporate spending on KM will increase to 5.5 percent of revenues within the next three years, which is more than most European firms spend on product R&D (Havens and Knapp 1999). By 2001, according to the Gartner Group, enterprises that lack KM programs or infrastructure will lag KM-enabled companies by 30-40 percent in speed of deployment of new products and services (Havens and Knapp 1999).

The popularity of knowledge management is undeniable. The implications of KM, however, are less apparent. One of the most important implications for marketing managers is "our need to know what forms or organizational arrangements will cope most effectively with change imposed from outside and which of these forms will facilitate those internal changes so necessary to continuing economic progress (Lawrence and Lorsch 1967, forward)." This study seeks to examine the relationship between organizational knowledge (Supply Chain Management knowledge specifically) and organizational structure, advancing the current body of academic research and literature as well as providing valuable practical information for managers struggling to cope in knowledge-rich environments characterized by intense global competition and fast-paced technological change.

Supply Chain Management (SCM) is herein defined as "**a mechanism for coordinating specialists across the supply chain for the optimization of customer value**." SCM knowledge is defined as "**the tacit knowledge (i.e., skill or ability) of an organization evidenced in its performance of SCM related activities**." Although not tested, this study proposes that SCM knowledge leads to sustainable competitive advantage and greater profitability. SCM knowledge is particularly critical for firms operating in environments characterized by global competition, technological change, organizational restructuring, strategic decision-making, and new forms of inter-firm relationships (Handfield and Nichols 1999; Monczka and Morgan 1998; Tan, Kannan, and Handfield 1998). SCM involves the integration of all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end user, as well as the associated information flows (Handfield and Nichols 1999; Quinn 1997). SCM activities include effective internal coordination, coordinated activities with upstream suppliers and cooperative relationships with downstream customers (Handfield and Nichols 1999).

SCM knowledge is a strategic capability able to create and sustain competitive advantage. SCM is just beginning to find its way into the academic literature, despite its growing recognition and relevance, including reports of startling success from the automotive industry (e.g., Stuart et al. 1998) and indications that at least 25 percent of firms' operating costs are potentially being wasted due to supply chain inefficiencies (Quinn 1997). Despite the apparent benefits of a multilateral SCM strategy and the inevitable continuation of the forces that have encouraged its development, purchasing and marketing strategies seem rooted in the historical evolution of functional approaches to buying and selling (i.e., bilateral buyer-seller relationships). Despite the concern that all firms inevitably express related to supply issues, less than half of manufacturing firms are significantly involved in SCM practices (Quinn 1997).

Academic research in this important emerging area is even less prevalent. Weitz and Jap (1995) expressed disappointment regarding academia's inattention to SCM, noting, "scholars have been watching the world evolve rather than leading or even participating in its evolution (p. 309)." In an effort to remedy this situation, this study provides practical information for managers as well as meaningful empirical evidence to advance research in the areas of SCM, organizational knowledge, and organization structure.

Supply chain management practices and strategy have evolved over time and in relation to a number of other practices and research streams including alliances and networks, just-in-time (JIT), logistics and purchasing strategies, and market orientation (i.e., value creation strategies). This study develops the concept of SCM knowledge from several related concepts and literatures including epistemology, organizational knowledge, organizational learning, and knowledge-based theories of the firm.

Supply Chain Management

More than anything else, the evolution of SCM has been driven by the relentless growth of knowledge and technology. Thus, a brief historical review of the growth in knowledge provides a better understanding of the evolution of SCM. Henry Adams first described the explosive growth in knowledge in 1900. His observation of a geometric increase of knowledge over time in a number of areas led him to conclude, "no longer would any child be able to live in the same kind of world -- sociologically and intellectually -- as his parents and grandparents had inhabited (Bell 1973, p. 170)."

In addition to this change of pace or exponential growth in knowledge, firms have also experienced an attendant growth in organizational and market size and scope (i.e., larger organizations competing in larger / global markets). Galileo, more than 350 years ago, first laid down the "general principal of similitude," which, applied to modern organizations, suggests that as organizations grow in size and in the functions they have to perform, they must create specialized and distinct subsystems to deal with those functions. This in turn creates new and distinct problems of coordination, hierarchy, and social control (Parsons and Smelser 1956). This study suggests that SCM knowledge acts as a "specialized and distinct subsystem to deal with... [the]... problems of coordination, hierarchy, and social control" brought about by the growth of knowledge and the changing environments in which many firms now operate. In order to further understand SCM and its evolution we must explore its roots in alliances and networks, JIT, logistics and purchasing, and market orientation.

Alliances and Networks

Interorganizational cooperation is an essential attribute of SCM (Handfield and Nichols 1999; Monczka and Morgan 1998). Traditional (i.e., pre-alliance) organizational theory relies on vertical integration as the means by which firms buffer themselves from the environmental uncertainty created by increased knowledge and environmental changes (e.g., Pfeffer and Salancik 1978; Thompson 1967; Williamson 1975). However, as Achrol (1997, p. 58) suggests, "vertical integration in dynamic environments suffers from critical inefficiencies due to suboptimization." Simply stated, vertical integration lacks the speed and flexibility necessary to keep up with fast-paced environmental and technological changes.

Cooperative mechanisms, rather than hierarchical approaches, are more effective in environments high in uncertainty and rich in knowledge. Only through complex arrangements such as alliances and networks can firms integrate the diverse and disparate knowledge and technologies they need, while providing a mechanism that is fast, flexible, and adaptive (Hage 1980). Indeed, the metaphor of a supply "chain" suggests "links" between suppliers, manufacturers, and customers. Effective SCM requires interorganizational cooperation to avoid suboptimization and maximize the customer value generated within the supply chain. SCM practice and theory rely on networks and alliances to provide frameworks for coordinating specialist knowledge across the supply chain. Coordination within supply chains is not possible without these interorganizational frameworks.

In theory, maximizing customer value *via* supply chain cooperation leads to competitive advantage and superior rewards across the supply chain. However, this study acknowledges that the complexities of reality cause these relationships to be somewhat elusive. For example, one very real complication is that most firms are part of several, if not many, distinct supply chains. Conflicting perspectives of "customer needs" along with varying objectives, policies, and cultures may preclude optimal coordination of supply chain partners. In addition, the limited resources (i.e., specialist knowledge) of a supply chain member may be insufficient to meet the needs of every supply chain to which the firm belongs, thus creating competition for scarce resources between supply chains. These complications, however, do not undermine the importance of this study in providing timely, practical, and valuable insight into SCM knowledge and its relationship with organizational structure.

Just-in-Time

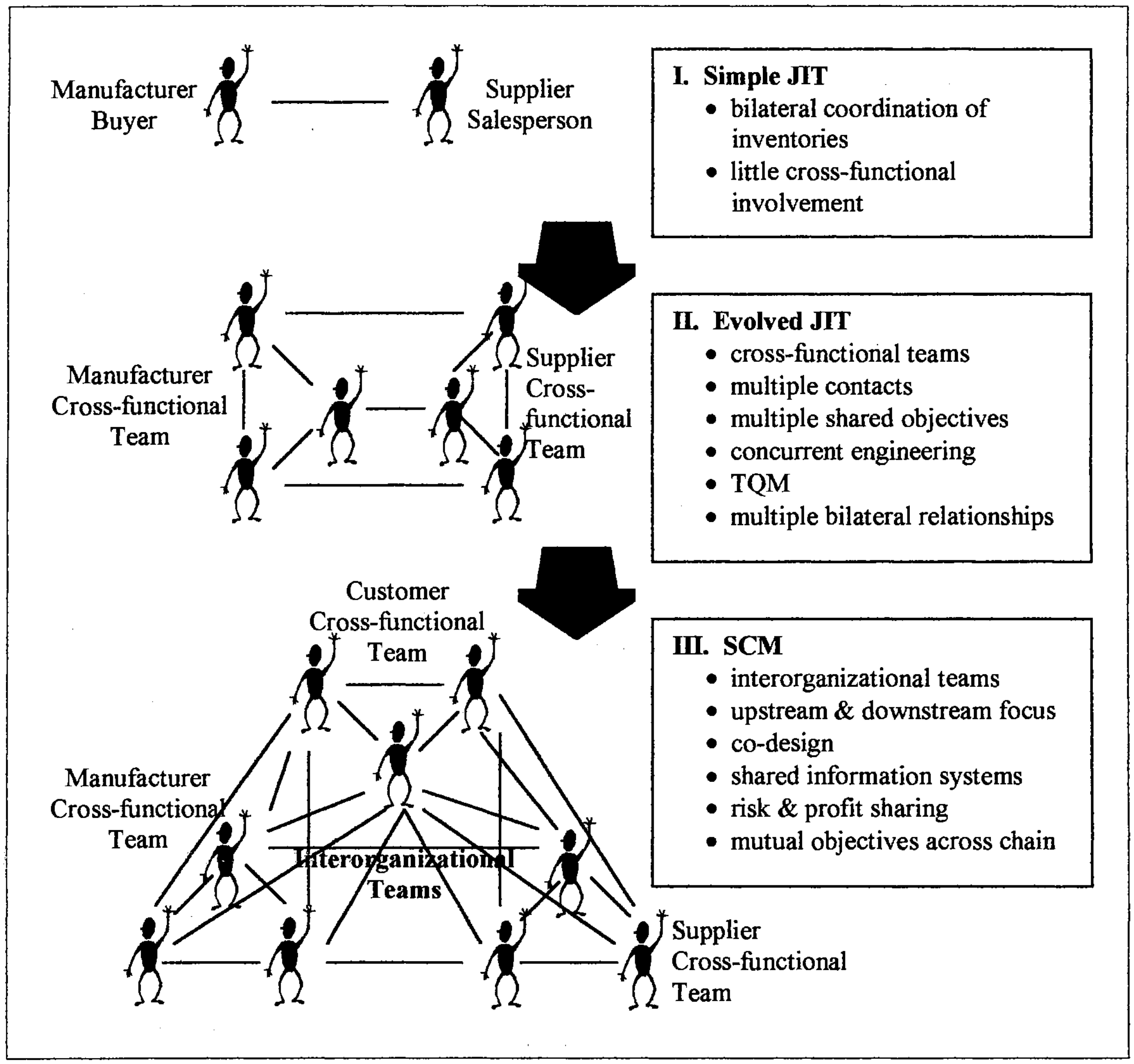

Figure 1. The Evolution of SCM from JIT

Although once thought of as merely a method of inventory control, just-in-time (JIT) has evolved to embrace "a philosophy that integrates the entire supply chain's marketing, distribution, customer service, purchasing, and production functions into one controlled process (Claycomb, Germain, and Dröge 1999, p. 2)." From a practical perspective, this study suggests that the term "supply chain management" better describes the broad purposes of supply chain coordination than does "just-in-time" which, despite the scope of its current philosophy, inevitably brings to mind a narrower view of simple inventory-based practices. Minahan (1996, p. 36) validates the evolution of SCM from JIT, noting that "Purchasing has ... modified JIT from a simple inventory control mechanism to a total supply chain management process that has tremendous influence on a company's bottom line."

JIT research also provides limited insight into the concept of SCM knowledge. Specifically, Germain and Dröge (1997) suggest that JIT includes a process dimension as well as a knowledge dimension. They define JIT knowledge according to Hage's (1980) concept of "task scope," or "the amount and variety of knowledge employed by the organization in its production of good and services (p. 383)."

JIT has grown in scope and scale from a bilateral inventory control system (i.e., kanban) to a process "so broad that it can encompass and integrate all aspects of operation techniques in any organization (Kim and Takeda 1996, p. 47)." This study suggests that JIT has evolved to become SCM. This study suggests that SCM is the most appropriate term to describe the coordination of supply chain activities.

Logistics and Purchasing

Interorganizational supply chain coordination has historically been of major interest to three main groups of practitioners and researchers: logisticians, marketers, and purchasers. Logistics practitioners and researchers traditionally focus on channel activities related to downstream supply chain partners (i.e., customers). These activities include order processing, finished goods inventory management, warehousing, distribution, and transportation. Marketing practitioners and researchers traditionally focus on integrating the needs of customers into the firm's internal processes and product development. A more in-depth discussion of market orientation is included later in this study.

The interest of purchasing practitioners and researchers focuses on the upstream supply chain (i.e., suppliers). However, purchasing is also in a unique position to observe, if not participate in, the internal and downstream SCM activities of the organization. Indeed, this study agrees that "Purchasing has been recruited to lead [the] charge [towards] total supply chain management (Minahan 1996, p. 36)." Tan, Kannan, and Handfield (1998) argue that SCM practices evolved from a plethora of related purchasing strategies such as integrated purchasing, supplier integration, buyer-supplier partnerships, supply base management, strategic supplier alliances, and supply chain synchronization. Undoubtedly, the purchasing function is in an ideal position from which to drive and/or observe supply chain management practices.

Despite Purchasing's "catbird seat" related to SCM activities, increasing SCM knowledge will push organizations toward broad participation and coordination unmanageable by any single function. John Manrodt, vice president of A.T. Kearney, a well-known consulting firm, writes:

> Today, the vision of the supply chain has expanded considerably to characterize what is called the extended enterprise...this approach views the supply chain as product and information flow, encompassing all parties beginning with the supplier's suppliers and ending with consumers or end users. This supply chain view flows as bi-directional. It can be defined as groups of enterprises (suppliers, customers, producers, and service providers) that link together to acquire, purchase, convert/manufacture, assemble, and distribute goods and services to the ultimate consumers or end users (Harrington 1995, p. 30-31).

Market Orientation

The link between SCM and market orientation is their common objective of maximizing customer value (i.e., meeting or exceeding the needs of the customer). Hunt and Morgan (1995) define the marketing concept, the basis of market orientation (Kohli and Jaworski 1990), as a customer orientation, an integration of marketing activities, and a focus on profits (i.e., value) versus sales. By comparison, SCM seeks to coordinate the activities of an entire supply chain in order to maximize the value provided to the end customer. The similarity is apparent.

A market orientation demands a focus on the needs and expectations of customers. SCM seeks to maximize the value provided to the customer by coordinating specialist knowledge within the supply chain, including the knowledge resident in customers. In theory, SCM is the most effective means of delivering customer value because it seeks to coordinate or orient all value-creating activities within an entire supply chain toward the customer. Any other approach would suffer from some degree of suboptimization.

Hunt and Morgan (1995) note that a market orientation requires an integration of marketing activities. Again, SCM effectively integrates marketing activities *via* the coordination of information and product flow, both up and down the supply chain. Internally, effective SCM means the entire organization and all of its activities are focused on the end customer. In addition, both upstream (i.e., supplier) and downstream (i.e., customer) supply chain activities focus on the end-user, fully integrating customer needs in all processes and effectively integrating all value-creating activities.

Finally, just as a market orientation seeks to maximize profitability, SCM seeks to maximize customer value, the ultimate driver of profitability. Value, not volume, is the mutual objective. The similarities between market orientation and SCM provide evidence of the importance of SCM to marketing practitioners and researchers. The importance of SCM as a mechanism focused on customer value has not gone entirely unnoticed by marketing researchers and practitioners. Slater (1997) argues for a customer value-based theory of the firm and suggests that firms that consistently provide superior value to their customers can achieve superior performance. Peter Drucker (1973, p. 79) wrote, "To satisfy the customer is the mission and purpose of every business." Other research that supports and contributes to value-based theory includes Alderson (1957), Anderson (1982), Day and Wensley (1988), Dickson (1992), Hunt and Morgan (1995), Kohli and Jaworski (1990), Slater and Narver (1995), and Webster (1992).

Supply Chain Management Knowledge

Nam et ipsa scientia potestas est -- "knowledge is power," said Sir Francis Bacon (1561-1626). More recently, Nonaka (1991) writes, "In an economy where the only certainty is uncertainty, the one sure source of lasting competitive advantage is knowledge (p. 96)." This study develops the concept of SCM knowledge based on a synthesis of SCM and knowledge-based literatures and theory. SCM knowledge is the tacit knowledge (i.e., skill or ability) evidenced in an organization's (and/or supply chain's) effective performance of SCM related activities. Because SCM knowledge is a type of knowledge, an understanding of SCM knowledge requires a review of knowledge itself, as well as organizational knowledge, and knowledge-based theories of the firm.

Epistemology

Epistemology is theory of knowledge. Although knowledge is very broad in its scope, a review of the epistemology literature clearly supports the concept of knowledge of a "special thing" including "workaday practices (Goldman 1986, p. 13)." It is apparent that SCM knowledge is knowledge of a "special thing" and includes "workaday practices." The ancient philosophy of Plato also recognized the knowledge of "special things" (Rouse 1984). Hayek (1945) notes the potential value of such knowledge:

> Today it is almost heresy to suggest that scientific knowledge is not the sum of all knowledge. But a little reflection will show that there is beyond question a body of very important ... knowledge ... the knowledge of the particular circumstances of time and place. It is with respect to this that practically every individual has some advantage over all others in that he possesses unique information of which beneficial use might be made (p. 521).

Von Krogh and Roos (1995) suggest that one purpose of epistemology is to gain a better understanding of the knowledge development within a specific discipline. Herein lies another connection between epistemology and this study. That is, this study examines the knowledge development of SCM, a specific discipline, thus fulfilling one of the purposes of epistemology.

The epistemology literature provides other examples of types of knowledge that appear to have similarities with SCM knowledge. Specifically, Scheler (1925) introduces *herrschaftswissen*, or knowledge for the sake of action or control. Machlup (1962) classifies "practical knowledge (p. 21)," as knowledge useful in a person's work, decisions, and actions. These and other knowledge types, discussed further in Chapter 2, provide support for the concept of SCM knowledge as a practical, activity-related, tacit knowledge.

Although it is apparent that specific types of knowledge exist (e.g., SCM knowledge), providing a precise definition of knowledge is problematic and beyond the scope of this study. Referring to the frustration of earlier epistemological researchers as relates to defining knowledge, "there is no exact usage of the word knowledge; but we can make up several such usages, which will more or less agree with the ways the word is actually used (Wittgenstein 1958, p. 27)."

Finally, the epistemology literature provides evidence that knowledge builds on itself and is self-reinforcing. This idea helps explain the phenomenal growth of knowledge and the widening gap between organizations that effectively use knowledge and those that do not.

Organizational Learning and Knowledge

Organizational knowledge assumes that learning can take place, and knowledge be accumulated and utilized, by a group or system, not just by individual human beings. Theorists such as Chandler (1962), Katz and Kahn (1966), and Thompson (1967) suggest that long-term survival and growth is the ultimate criterion of organizational performance and is the result of organizational learning. Organizations must learn in order to survive (Barnard 1938; Lawrence and Dyer 1983; Lawrence and Lorsch 1967).

Knowledge is a result of learning. More specifically, organizational knowledge is the result of organizational learning (Fiol and Lyles 1985; Huber 1991; Simon 1969).

Slater and Narver (1995) argue, "At its most basic level, organizational learning is the development of new knowledge or insights that have the potential to influence behavior (p. 63)." Although knowledge is the result of learning, learning does not always lead to effective knowledge. As Huber (1991) notes, "...learning does not always increase the learner's effectiveness, or even potential effectiveness ... entities can incorrectly learn, and they can correctly learn that which is incorrect (p. 89)." Huber (1991) further suggests the most appropriate measure of knowledge is intentional activities. This argument supports the methodology used in this study of measuring SCM knowledge by observing SCM-related activities.

A Knowledge-based Theory of the Firm

Grant (1996a, 1996b), Grant and Baden-Fuller (1995), and Spender (1996a, 1996b) propose a knowledge-based theory of the firm. Their combined research suggests the integration of organizational knowledge is the key to organizational capability and performance. Researchers such as Drucker (1985, 1988) and Nonaka and Takeuchi (1995) first established the concept of organizational knowledge as a strategic factor of production. Both Spender and Grant refer to resource-based theory as the fundamental root of knowledge-based theory, knowledge being the essential resource.

Adding to the work of these early researchers, Nelson and Winter (1982) and Polanyi (1962, 1967) refine the concept and definition of "tacit" knowledge as the organizational knowledge type of primary value-creation potential. Tacit knowledge is "know-how" and is experiential. SCM knowledge is a tacit knowledge which is based on various practices and experiential-based expertise. Work by Fuller (1988), a sociologist, and Plotkin (1994), a psychobiologist, suggests "organizations, firms, species and societies evolve by adapting the body of knowledge shared by their members, and that much of the process takes place at the tacit level (Spender 1996a, p. 50)."

The tacit dimension of SCM knowledge is the most interesting because of its idiosyncratic nature and link to application and routines. Indeed, Nelson and Winter (1982) suggest that an organization's application of better routines is an indication of increased knowledge. Spender (1996a) further describes the value of tacit organizational knowledge as follows:

> ... social types of knowledge are either publicly available or collective and embedded in the firm's routines, norms and culture. Since the latter are generated internally and remain 'of the firm,' they give rise to the economic rents associated with effective collective practice which we labeled 'Penrose rents' ... collective knowledge is the most secure and strategically significant kind of organizational knowledge (p. 52).

Supply Chain Management Knowledge

SCM knowledge is rooted in the value-creating tacit knowledge retained within organizations and specialists throughout the supply chain. This knowledge is evidenced by the effective performance of SCM related activities. Recent work by Li and Calantone (1998) in market knowledge competence provides support for this study by effectively introducing the concept of market knowledge competence into the mainstream marketing literature.

Supply Chain Management Knowledge and Organizational Structure

Lawrence and Lorsch (1967) use the analogy of human anatomy to illustrate the important relationship between strategy and structure. Just as the body has a variety of specialist organs and tissues that are coordinated through a nervous system and brain, so organizations seek to effectively coordinate and integrate the divergent specializations that are necessary for its survival and growth. Organization structure is the framework within which the organization functions (Dalton et al. 1980). Just as there is a relationship between the anatomy (or structure) of a body and the activities that it can perform, so there is a relationship between organizational activities such as SCM and organizational structure. This study provides an empirical test of the relationships between SCM knowledge and organization structure.

Organizational Structure

There is a rich history of empirical research related to the components or elements of organization structure. The Aston researchers (Pugh et al., 1968, 1969), a group of English academicians, were the pioneers of organizational structure research and among the first to isolate the central dimensions of organizational structure. These and other studies of organizational structure consistently identify and include the elements of centralization, formalization (e.g., performance control), and specialization (Champion 1975; Miller 1991; Mintzberg 1979; Pugh et al. 1968; Weber 1946). Miller, Glick and Huber (1991) suggest that centralization, formalization, and specialization are the three most important and popular organizational structure variables. More recently, integration, a fourth dimension of structure, has been added (Achrol 1991; Germain, Dröge, and Daugherty 1994; Olson, Walker, and Ruekert 1995; Workman 1993). In order to ensure completeness, all four of these structural elements: centralization, performance control, specialization, and integration are included in this study.

Centralization is the "average locus of decision-making over a list of repeated decisions along a hierarchical scale running from operative level up to decisions taken above the chief executive (Child and Mansfield 1972, p. 370)." This study suggests that organizations operating in cooperative frameworks (e.g., alliances, networks, and cooperative supply chains) may be more decentralized (Davy et al. 1992; Giunipero and Law 1990; Ruekert, Walker, and Roering 1985). Hage (1980) suggests that increased specialization brought about *via* increased knowledge leads to greater decentralization.

Performance control involves the use of performance monitoring and control systems. Handfield and Nichols (1999) propose that effective SCM relates positively to the use of formalized performance control systems. Other research provides empirical support for a relationship between total quality management effectiveness and formal performance controls (Carter and Narasimhan 1994).

Specialization is the relative number of specialized functions or jobs within an organization, not by the number of tasks performed by an individual worker. Research suggests that increases in knowledge and complexity predict specialization (Achrol 1991; Hage 1980). Therefore, this study proposes that as SCM knowledge increases specialization will also increase.

Integration refers to the coordination of differentiated or specialized subunits in order to minimize suboptimization and orient the total system towards common objectives. The current popularity of cross-functional teams and the tearing down of "functional silos" are illustrative of modern integration efforts. Integration is critical to an organization's ability to coordinate specialist knowledge. As knowledge increases, organizations become more complex and differentiated, and integrative devices become more important (Galbraith 1973; Lawrence and Lorsch 1967).

Figure 2 illustrates the proposed relationships between the dimensions of SCM knowledge and the elements of organization structure.

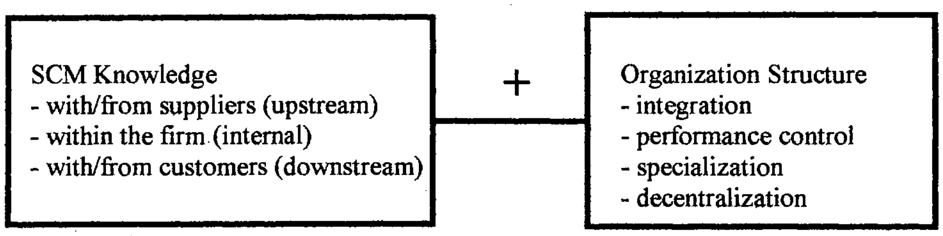

Figure 2. Theoretical Overview of SCM Knowledge and Organizational Structure

Controlling for Context

Any investigation of the determinants of structure should include the simultaneous analysis of size, technology (e.g., product complexity) and uncertainty (Miller and Dröge 1986). This study controls for each of these context variables in linear as well as non-linear fashions. Although there is some disagreement as to the relative importance of size as compared to other context variables, research suggests that size does affect structure (Hall, Haas, and Johnson 1967). Empirical evidence supports the argument that larger organizations have greater specialization and decentralization (Child

1973; Khandwalla 1974; Pugh et al. 1968). Other research suggests the strategies of smaller firms may have dissimilar relationships to structure than those of larger firms (Miller and Dröge 1986).

Clearly, the technology or complexity of an organization has an important impact on its structure, yet, only a limited number of studies have attempted to operationalize the concept (Hall, Haas, and Johnson 1967; Khandwalla 1974; Singh 1985). This study operationalizes technology in terms of product complexity (e.g., Khandwalla 1974; Singh 1985). Because the specific impact of complexity on organizational structure remains somewhat unclear, the empirical results of this study provide an important contribution to the literature. This study takes an exploratory approach regarding moderating effects of context on the hypothesized relationships between SCM knowledge and organization structure.

Finally, the importance of environmental uncertainty is well-documented (Burns and Stalker 1961; Galbraith 1973; Lawrence and Lorsch 1967; Thompson 1967). Environmental uncertainty relates to the level and unpredictability of changes in customer tastes, competitive behavior, technology, etc. (Miller and Dröge 1986). As uncertainty increases, it is generally assumed that specialization increases (Lawrence and Lorsch 1967), there is a greater need for integration (Galbraith 1973; Ruekert, Walker and Roering. 1985), and decentralization increases (Burns and Stalker 1961). However, despite widely held perceptions, the empirical support is less consistent (Mintzberg 1979) and the results of this study provide a valuable contribution to the literature. As with the other context variables, this study takes an exploratory approach, asking whether environmental uncertainty moderates the hypothesized relationships.

Purpose of This Study

This study specifically addresses the following research question: Is there a relationship between supply chain management knowledge and organization structure? In addition, does the level of organization size, product complexity, or environmental uncertainty moderate the relationships? In answering these questions, this study develops the concept, proposes a definition of SCM knowledge, and operationalizes the concept by examining specific internal activities, as well as upstream and downstream interorganizational activities, that reflect the relative level of SCM knowledge within an organization. This study examines the relationships between the dimensions of SCM knowledge (upstream, internal, and downstream) and the elements of organization structure (integration, performance control, specialization, and decentralization), as well as the relationships between context variables and the elements of organization structure, using regression analysis techniques. In addition, this study examines size, product complexity, and environmental uncertainty in regards to any moderating effects that they may have on the relationships between SCM knowledge and organizational structure.

SCM knowledge involves internal activities, as well as interaction with upstream suppliers and downstream customers. Consequently, it is necessary to divide SCM knowledge into three separate variables: upstream SCM knowledge (i.e., knowledge exhibited in boundary spanning activities with upstream suppliers), internal SCM knowledge (i.e., knowledge exhibited in internal SCM related activities), and downstream SCM knowledge (i.e., knowledge exhibited in boundary spanning activities with downstream customers). This study marks the first contribution of a study of SCM knowledge to the business literature.

The objectives of this study are: (1) to develop a definition of, and measures for, the construct of SCM knowledge, and (2) to examine empirically the conceptualized relationships between the three dimensions of SCM knowledge and the four elements of organization structure. Figure 3 graphically illustrates the model to be tested.

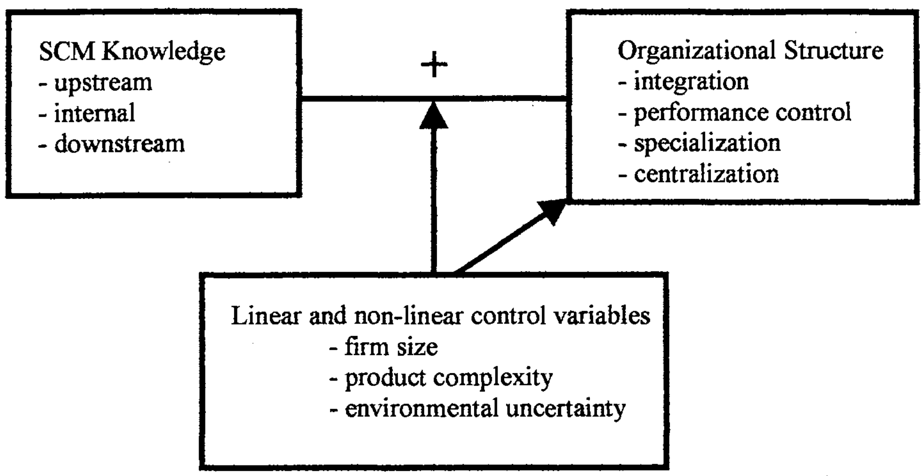

Figure 3. Proposed Model of SCM Knowledge and Organizational Structure

This study breaks new ground by providing a theory-based definition of SCM knowledge, as well as a means for measuring SCM knowledge. The results of this study provide a valuable contribution in the areas of marketing, purchasing, SCM, and epistemology research.

Design Overview

Although any of several different methods may be appropriate, this study employs a survey research method. The units of analysis in this study are unique manufacturing operations. That is, in large companies with multiple divisions, the unit of analysis is a particular manufacturing operation (i.e., business unit). Consistent with research that suggests purchasing personnel play a central role in SCM and JIT activities (Minahan 1996; Monczka and Morgan 1998; Tan, Kannan, and Handfield 1998), this study collects data from purchasing managers. Where possible, this study collects data from two sources within the same operation in order to check for any response bias (Phillips 1981). The sample frame for the study is strategic-level purchasing managers from manufacturing organizations generally engaged in business-to-business marketing.

The study measures the criterion variables, elements of organization structure, using existing and proven scales. The dimensions of SCM knowledge (upstream, internal, and downstream) are the predictor variables and are measured by adapting existing scales originally developed for broad measures of advanced JIT. The context variables of firm size, product complexity, and environmental uncertainty are also included as predictor variables, and are measured using existing and proven scales. The analyses employ regression techniques to test the research hypotheses as well as any direct relationships between the context variables and the elements of organization structure. Further analyses employ regression techniques using split samples to test for any moderating effects of the context variables on the hypothesized relationships between SCM knowledge and organization structure.

Summary of Contributions

This dissertation makes theoretical as well as managerial contributions, particularly in the areas of marketing, purchasing, and supply chain management. This study extends existing research, empirically tests conceptual relationships, and advances the understanding of organizational knowledge and structure.

Theoretical Contributions

The theoretical rationale for considering the effect of SCM knowledge on organizational structure is rooted in resource-based theory (Barney 1991; Rumelt 1987; Wernerfelt 1984) and the emerging knowledge-based school of thought (Grant 1996a, 1996b; Spender 1996a, 1996b). Resource-based theory suggests that firms must obtain specific resources, competencies, and capabilities in order to position themselves strategically within markets and environments (Wernerfelt 1984). The knowledge-based school adds that the resource of primary concern is knowledge (Spender 1996a, 1996b).

Thus, both the resource-based and knowledge-based theories provide the impetus for this study. The specific theoretical contributions of this research are:

1. Existing research in supply chain management, organizational knowledge, and organizational structure is extended.
2. Conceptual relationships linking SCM knowledge and organizational structure are empirically tested.
3. Context variables are tested for any direct effects they may have on organizational structure, as well as for any moderating effects they may have

on the hypothesized relationships between SCM knowledge and organization structure.

4. An internal perspective of marketing and supply chain management is advanced through the integration of organizational knowledge, organizational epistemology, supply chain management, and market orientation.

Managerial Contributions

In addition to the theoretical contributions, this study has a number of important implications for managers. First, the operationalization of activities and skills associated with SCM knowledge is useful in determining how to create and sustain a knowledge-based competitive advantage. SCM knowledge has been linked to profitability (Claycomb, Germain, and Dröge 1999; Edvinsson and Sullivan 1996), reduced system variance (Flynn, Sakakibara and Schroeder 1995), reduced cycle times and system inventories (Handfield and Nichols 1999; Tan, Kannan, and Handfield 1998), and better product design *via* concurrent engineering (Hartley 1992). By knowing what activities and structures facilitate and encourage SCM knowledge, managers can actively support and encourage those structures and activities. Also, by understanding the specific conditions (e.g., low versus high environmental uncertainty) under which the relationships between SCM knowledge and organization structure hold, managers can anticipate changes in structure related to specific changes in the context in which they operate.

Additionally, research suggests that as structure comes into alignment with environment workers are generally more satisfied (Lawrence and Lorsch 1967; Rice

1963) and more motivated (White 1963). SCM knowledge is a system-wide approach with the potential of benefiting all value-adding activities within the supply chain. Lee and Billington (1992) suggest the more complex a network of suppliers, manufacturers, and distributors, the more likely the chance of gaining operational efficiencies by attending to shared concerns. Finally, Senge (1997) suggests that the creation and sharing of knowledge will have theoretical and practical implications for management that are, "impossible for us to overestimate (p. 32)."

Outline of the Dissertation

This dissertation is organized into five separate chapters. The first chapter introduces the dissertation. It reviews the purpose, structure, and scope of this study. The second chapter explores the evolution and importance of supply chain management knowledge as an important theoretical and strategic development. The literatures of epistemology and organizational knowledge are also explored in support of the SCM knowledge concept. Finally, the elements of organizational structure and the context variables are reviewed and discussed and specific hypotheses are proposed. Chapter 3 describes the research design and methodology used in conducting this study. Further discussion elucidates the unique issues associated with this study, along with the actions taken to ensure the validity of the study. In Chapter 4, results of the hypotheses testing are presented and reviewed. Results of the analysis of context variables are also presented in Chapter 4. Implications of this study for marketing researchers and managers, limitations, and opportunities for further research are presented in Chapter 5.

CHAPTER II

LITERATURE REVIEW

Increasing global competition, the escalating pace of technological change, pressure to restructure organizations, an increase in strategic approaches to decision-making, and the emergence of new forms of inter-firm relationships have all contributed to the emergence of Supply Chain Management. Supply Chain Management (SCM) is a mechanism for coordinating specialists across the supply chain in order to maximize customer value. SCM Knowledge is the tacit knowledge of an organization evidenced in its effective performance of SCM related activities. SCM knowledge may be considered a subset of Knowledge Management (KM), a topic of great interest to practitioners and theorists. Indeed, according to Havens and Knapp (1999), as of September, 1999, over 37,900 web pages and 266 books specifically address KM. SCM involves the integration of all activities associated with the flow and transformation of goods from the raw materials stage (extraction) to the end user, as well as the associated information flows (Handfield and Nichols 1999; Quinn 1997). Materials and information flow both up and down the supply chain. SCM includes internal activities, activities with upstream suppliers, and activities with downstream customers (Handfield and Nichols 1999).

SCM is just beginning to find its way into the academic literature, despite its growing recognition and relevance. Although ahead of academia, even management has been somewhat slow to implement SCM. Supply chain management strategy has evolved over time and in relation to a number of other practices and research streams. In order to understand SCM, it is necessary to review its evolution from the perspective of several related and antecedent literatures. These literatures include alliances and networks, just-in-time (JIT), logistics and purchasing strategies, and market orientation (i.e., value creation strategies). Further, in order to understand SCM as a knowledge-based mechanism, it is necessary to review the literatures of epistemology, organizational knowledge, organizational learning, and knowledge-based theories of the firm.

The Evolution of SCM

The evolution of SCM has been driven primarily by a continuous exponential growth in knowledge and technology. The first to take note of this phenomenon was Henry Adams, grandson of John Quincy Adams. Henry's quest for understanding began with an epiphany that occurred in the Gallery of Machines at the Great Exposition of 1900, and was later recorded by Bell (1973) as follows:

> It was in the great hall of dynamos that this revelation took place. In the energy churning from the dynamo, Henry Adams felt he had caught a glimpse of the secret that could unravel the complexities men had begun to note about their time. In the nineteenth century, he wrote, society by common accord measured its progress by the output of coal. The ratio of increase in the volume of coal power, he now said exultantly, might serve as a 'dynamometer.' Between 1840 and 1900, he pointed out, coal output had doubled every ten years; in the form of utilized power, each ton of coal yielded three or four times as much power in 1900 as it had in 1840. The gauge on the dynamometer of history had started out with arithmetic ratios; but new forces emerging around 1900 were creating new "supersensual" forces. What all this revealed, he said, was the foundation for a new social physics, for a dynamic law of history, the fundamental secret of social change - the law of acceleration (p. 168, 169).

Since the age of Henry Adams, the rapid rate of technological progress and knowledge creation has been widely noted. For example, measures of progress such as the speed for circumnavigating the globe have decreased exponentially by a factor of two every quarter century from Nelly Bly's voyage around the world in 1889 to the first transworld aircraft flight in 1928, and by a factor of 10 from that time until the first manned space orbiter (Bell, 1973). Within virtually every area of science, medicine, research, technology and exploration, the story is the same -- exponential growth. The implications of this revelation are profound. "No longer would any child be able to live in the same kind of world -- sociologically and intellectually -- as his parents and grandparents had inhabited (Bell, 1973, p. 170)." Indeed, it is this phenomenal growth in knowledge and technology that has caused the emergence of numerous new branches of business and technology to emerge, including SCM knowledge, the subject of this study.

In addition to the exponential growth of knowledge, Bell (1973) notes another important factor which he called "change of scale (p. 172)." Change of scale has influenced the evolution of SCM as well as the organizational structures and forms necessary to support SCM. Bell argues that "No biological organism or human institution which undergoes a change in size and a consequent change of scale does so without changing its form or shape (p. 172)." Galileo, more than 350 years before Bell, first laid down this "general principal of similitude." The biologist Thompson (1963) described this general principal of similitude, or change of scale, thus:

> (Galileo) said that if we tried building ships, palaces or temples of enormous size, yards, beams and belts would cease to hold together; nor can Nature grow a tree nor construct an animal beyond a certain size while retaining the proportions and employing the materials which suffice in the case of smaller structures. The thing will fall to pieces of its own weight unless we...change the relative proportions (p. 27).

This same phenomenon, exhibited in business organizations, means that as institutions grow in size and in the functions they perform, they are driven to create specialized and distinct subsystems to deal with these functions, which in turn create new and distinct problems of coordination, hierarchy, and social control (Parsons and Smelser 1956).

Bell (1973) notes, "the pace of change and the change of scale -- are the organizing ideas for the discussion of the central structural components of the post-industrial society, the dimensions of knowledge and technology (p. 174)." As is widely recognized, knowledge and technology are also the key drivers behind the emergence of SCM (Handfield and Nichols 1999). Given this background, we now embark on an exploration of the literatures associated with alliances and networks, just-in-time, logistics and purchasing strategies, and market orientation. Together, these knowledge streams provide a broad perspective and understanding of the evolution of modern supply chain management.

<u>Alliances, Networks, and SCM</u>

Interorganizational alliances and networks are very much a part of supply chain management practice and theory (Handfield and Nichols 1999; Monczka and Morgan 1998). The same factors that scholars have associated with the formation of alliances and cooperative strategies, notably environmental uncertainty and skill and resource heterogeneity (Dwyer, Schurr, and Oh 1987; Varadarajan and Cunningham 1995), are also associated with the evolution and emergence of SCM (Handfield and Nichols 1999).

Achrol (1997), in his writings on interorganizational networks, describes the environmental conditions that drive the formation of alliances and networks as well as supply chain management as follows:

> Environments are being disturbed by an increasing pace of technological change, fueled by an explosion in the growth and availability of knowledge. The proliferation of technological and managerial know-how is dismantling economic and political boundaries and slowly but surely moving the world toward a borderless marketplace. The impact of technological change is intensified in global environments that are densely interconnected and interdependent (p. 58).

Alliances and networks provide a framework within which SCM (i.e., coordination of specialist knowledge within the supply chain) can take place. Without alliances and networks there is no supporting framework within which interfirm coordination can take place. Therefore, this study proposes that alliances and networks, in one form or another, are prerequisite to the evolution of SCM.

Before the advent of SCM and the popularity of alliances and networks, traditional organizational research suggested that firms could buffer themselves from uncertainty *via* vertical integration (Pfeffer and Salancik 1978; Thompson 1967; Williamson 1975). However, Achrol (1997) notes that "vertical integration in dynamic environments suffers from critical inefficiencies due to suboptimization. In dynamic environments, organizational efficiency is defined in terms of a firm's speed and agility in processing information (p. 58)." Turbulent, knowledge-rich environments are better addressed *via* cooperative mechanisms rather than traditional hierarchical responses. This point is critical to the explanation of the emergence of SCM. Postindustrial environments are relatively turbulent and knowledge-rich. Within such environments, knowledge and information are replacing capital and energy as the primary wealth-creating assets (Bell 1973). Society and organizations deal with increasing knowledge by increasing task specialization. As specialization increases, efficiency demands a mechanism for coordinating the diverse, yet complementary, knowledge held by an ever increasing number of specialists. SCM provides this mechanism, and alliances and networks provide a framework within with SCM can operate.

Drucker (1988) envisages the typical business of 2008 as resembling a hospital, a university, or a symphony orchestra. "Like them, the typical business will be knowledge based, an organization composed largely of specialists who direct and discipline their own performance through organized feedback from colleagues, customers, and headquarters (p. 45)." Providing insight into modern SCM practices, Drucker (1988, p. 45) refers to "knowledge based" coordination across organizational boundaries, a concept descriptive of, and fully embraced by SCM.

Hage (1980) points to the "explosion in knowledge and the concomitant changes in the speed of technological change (p. 28)" as drivers of the need for interorganizational coordination and networks. He suggests that only through complex arrangements such as interorganizational networks can firms integrate the diverse and disparate pieces of new knowledge being generated at a geometrically increasing rate. Networks provide a framework and SCM provides a coordination mechanism for firms to be flexible, fast, and adaptable.

Achrol (1997) heralds the demise of the vertically integrated, multidivisional firms of the 20th century and the emergence of vertically disaggregated firms. SCM processes are evolving to exploit the potentials associated with coordination and avoid the inefficiencies of suboptimization. Achrol (1997) notes,

> The vertically disaggregated network firm is able to generate the highest levels of performance in its individual functional units while maintaining flexibility for the system as a whole. The individual units are organized to maximize their fit with their own knowledge environments, environments that pose special knowledge processing pressures of their own (p. 59).

Further, Achrol (1997) argues that effective interorganizational integration involves upstream supplier firms as well as downstream distributor firms and customers, a perspective that completely coincides with the modern view of SCM.

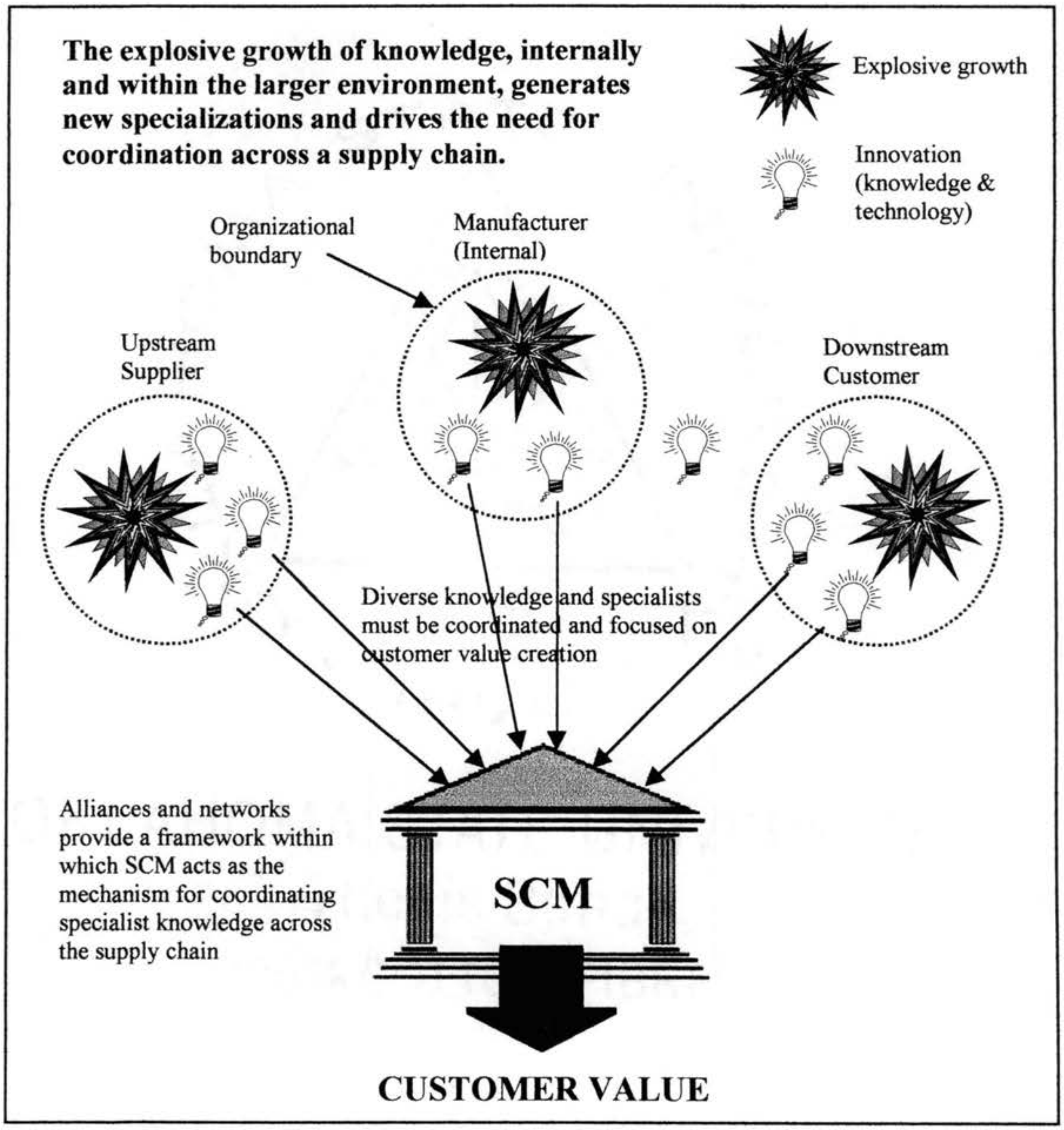

Fig. 4. The Explosion of Knowledge and the Emergence of SCM

In summary, SCM practice and theory is rooted in the theory and practice of alliances and networks. Supply chains, by their very nature, consist of alliances and networks of suppliers, manufacturers, distributors, sellers, consumers, etc. Gomes-Casseres (1994) suggests that alliances and networks have such great competitive potential that a new form of competition, group vs. group, is developing. Effective SCM requires effective alliances and networks that form a framework within which the mechanism of SCM can operate to coordinate specialist knowledge. The result is the maximization of customer value. Any discussion or study of SCM is not complete without recognizing the fundamental role of alliances and networks.

Just-in-Time and SCM

Just-in-time (JIT) has evolved from a relatively simple practice of inventory reduction and waste elimination (Hobbs 1997) to "a philosophy that integrates the entire supply chain's marketing, distribution, customer service, purchasing, and production functions into one controlled process (Claycomb, Germain, and Dröge 1999, p. 2)," (see also, Gomes and Mentzer 1988; Kim and Takeda 1996; Sadhwani, Sarhan, and Kiringoda 1985). Interestingly, this latter definition is nearly identical with most modern definitions of SCM. Crediting the purchasing function for implementing the change, Minahan (1996) describes the evolution of SCM from JIT as follows: "Purchasing has ... modified JIT from a simple inventory control mechanism to a total supply chain management process that has tremendous influence on a company's bottom line (p. 36)." Taken together, these definitions clearly indicate an evolutionary relationship between

JIT and SCM (see Figure 1 for an illustration of the evolution from JIT to SCM). Tan, Kannan, and Handfield (1998) further explain this evolution as follows:

> During the 1980s, manufacturers utilized Just-in-Time (JIT), Total Quality Management (TQM), and other programs to improve manufacturing efficiency... Integrating purchasing and supply management with other key corporate functions allows a closely linked set of production processes to be formed. This allows organizations to deliver products and services to both internal and external customers in a more timely, effective manner. To further exploit the competitive advantages associated with integrated processes, organizations are also adopting a strategic approach to managing other elements of the supply chain. For example, companies are forming strategic alliances with suppliers and are viewing suppliers as partners instead of adversaries. This new integration has many labels in the literature, including integrated purchasing strategy, supplier integration, buyer-supplier partnerships, supply base management, strategic supplier alliances, supply chain synchronization, and supply chain management. While each addresses elements of the integrated processes, supply chain management (SCM) encompasses materials/supply management from the supply of basic raw materials to final product (p. 2).

Given the close evolutionary relationship between JIT and SCM, a review of the JIT literature is warranted. Early definitions of JIT generally revolve around the idea of "getting the right quantity of parts to the assembly line at the exact time they are needed for production (Minahan 1996, p.38)." More recent descriptions of JIT, however, suggest a process approaching parity with SCM. For example, Kim and Takeda (1996) note,

> JIT is so broad that it can encompass and integrate all aspects of operation techniques in any organization. JIT is also considered an integration of many different management practices such as total quality management (TQM), restructuring, business reengineering, benchmarking, and empowerment. As such, JIT is considered a broad-based manufacturing philosophy that can be implemented in a variety of manufacturing industries (p. 47).

Perhaps the most fully developed definition of JIT is advanced by Germain, Dröge, and Daugherty (1994), who write,

> The ultimate JIT channel system connects supplier, manufacturer, warehouser, retailer, and consumer by (1) matching product flows to consumption ... across boundaries and internally and (2) associating a timely information flow perfectly to product flows (p. 472).

Another indication of the evolutionary connection between JIT and SCM is found in their common reliance on interfirm alliances and networks. JIT researchers recognize the significance of the involvement of selected suppliers and customers (Ansari and Modarress 1990; Chandrashekar 1994; Flynn, Sakakibara, and Schroeder 1995; Freeland 1991; Germain and Dröge 1997; Inman 1990). The evolution of JIT has taken it well beyond its original concept. Although JIT practices continue to run the gamut from simple inventory control to complex system-wide coordination, JIT theory has evolved in scale and scope to the point where the term "SCM" better describes the theory and intent of its activities (i.e., system-wide coordination with common objectives).

Knowledge-based JIT was first proposed by Germain and Dröge (1997), who define knowledge as "the application of understanding to the practical problems of the firm...a resource in its own right, similar to labor and capital (p. 616)." Germain and Dröge's (1997) definition of JIT knowledge has its roots in the earlier work of Hage (1980), who proposed the concept of "task scope," defined as "the amount and variety of knowledge employed by the organization in its production of goods and services (p. 383)."

The evolution of SCM from JIT can be explained from a knowledge perspective. That is, the explosive growth of knowledge in general suggests that JIT knowledge has also grown at an exponential rate. Galileo's general principle of similitude, as applied to the growth of JIT knowledge, suggests that JIT is inescapably destined to change its form or shape. This study argues that the resulting form or shape to which JIT has evolved is

SCM. In other words, as JIT knowledge has grown in scope and scale from an inventory control system (kanban) to the integration of upstream, internal, and downstream value-added processes, its form and shape has changed into what is now better described as SCM knowledge rather than JIT knowledge.

Logistics and Purchasing Perspectives

Traditional approaches to SCM research and practice include logistics and purchasing. These perspectives seem to be slowly merging with a common emphasis on "integration, visibility, cycle time reduction, and streamlined channels (Tan, Kannan, and Handfield 1998, p. 2)." Historically, however, the interest of logistics researchers and practitioners has focused on SCM in relation to transportation, order processing, and finished goods inventories. On the other hand, the interest of purchasing researchers and practitioners has traditionally focused on SCM in relation to supplier relationships and inventories (e.g., raw materials and work-in-process). From management's perspective, it is cost reduction has given SCM its high visibility in manufacturing firms. This cost reduction focus is not surprising given that, on average, industrial firms continue to spend more than half of every sales dollar on purchased items (U.S. Bureau of Census 1985), and the fact that logistics and purchasing savings go directly to bottom line profitability (Dobler, Lee, and Burt 1984).

From a research perspective, nearly all of the early work in SCM has come from logistics and purchasing researchers. Farmer (1978), an early tiller in the soil of purchasing research, was one of the first to introduce the idea of reducing inherent supply chain costs by viewing the entire chain as a single process. Subsequently, Houlihan

(1987, p. 55) presented a "new approach to material management, supply chain management" which differs from traditional approaches in four respects:

1. It views the supply chain as a single entity rather than relegating fragmented responsibility for various segments in the supply chain to functional areas, such as purchasing, manufacturing, distribution and sales.
2. It depends upon strategic decision making. "Supply" is a shared objective of practically every function on the chain and is of particular strategic significance because of its impact on overall costs and market share.
3. It provides a different perspective on inventories, which are used as a balancing mechanism of last, not first, resort.
4. It requires an integrative approach to systems, not simply interface.

Houlihan (1987) further suggests that through effective SCM firms can balance the often conflicting objectives of marketing, sales, manufacturing, and distribution, while also reacting more quickly to changing environmental conditions.

Stevens (1989) defines SCM as the "connected series of activities that deals with planning, coordinating, and controlling material, parts, and finished goods from suppliers to customers (p. 3)." He also suggests three perspectives of the management of material flow related to an integrated supply chain: strategic, tactical, and operational.

Leenders, Nollet, and Ellram (1994) emphasize the critical position of purchasing as the gateway to suppliers, and the need to open that gate in order to implement effective upstream SCM with suppliers. Minahan (1996) also takes a purchasing perspective of SCM, writing, "Purchasing has been recruited to lead this charge (p. 36)." Ghingold and Johnson (1997) recognize the potential value of the knowledge held by upstream suppliers and suggest that firms take specific steps to locate and acquire that knowledge as an integral part of their SCM strategy.

One of the most recent publications related to SCM is Handfield and Nichols' (1999) book on SCM. They describe supply chains and supply chain management as follows:

> Supply chain - encompasses all activities associated with the flow and transformation of goods from the raw materials stage (extraction), through to the end user, as well as the associated information flows. Materials and information flow both up and down the supply chain. It includes internal functions, upstream suppliers, and downstream customers.
>
> Supply chain management (SCM) - the integration of these activities through improved supply chain relationships, to achieve a sustainable competitive advantage.

Consistent with Handfield and Nichols' definition, the definition of SCM used in this study stresses integration and the inclusion of all internal functions as well as upstream and downstream supply chain partners, for the purpose of achieving sustainable competitive advantage (i.e., maximizing customer value). The integration of downstream supply chain components (i.e., customers and distributors) with upstream activities (i.e., design, development and supply) is driving SCM to become more than a purchasing or logistics strategy. Indeed, with its objective of maximizing customer value, SCM might better be classed as a marketing strategy or a total network strategy.

Market Orientation and SCM

The emergence of SCM as more than a logistics or purchasing strategy raises the question of where in the business literature it belongs. Given the close relationship of SCM with alliances and networks as well as the objective of SCM to maximize customer value, it seems apparent that SCM deserves a place in the marketing literature. Indeed, based on its objective of maximizing customer value, SCM epitomizes the marketing concept. The following discussion is provided in support of this argument.

The concepts of customer value and market orientation have their foundations in the marketing concept (Kohli and Jaworski 1990). The marketing concept emerged in the 1950s and 1960s and is generally considered to be a cornerstone of modern marketing. The marketing concept maintains that "(1) all areas of the firm should be customer oriented, (2) all marketing activities should be integrated, and (3) profits, not just sales, should be the objective (Hunt and Morgan 1995, p. 11)." Just so, SCM (1) focuses on the end customer, while (2) seeking to integrate all value-adding activities across the supply chain, with (3) the objective of value maximization and long-term competitive advantage. The value maximization objective of SCM is consistent with the marketing concept of profit maximization since, arguably, value maximization allows firms to obtain a sustainable competitive advantage, demand higher prices, and increase profitability. The parallels between SCM and the marketing concept are striking.

It is suggested that market orientation strategies (e.g., SCM) enable firms to produce more efficiently and effectively (Glazer 1991). Slater (1997) further argues,

> A customer value-based theory of the firm would say that superior performance accrues to firms that have a customer value-based organizational culture [i.e., market orientation], complemented by being skilled at learning about customers and their changing needs and at managing the innovation process, and that organize themselves around customer value delivery processes (p. 164).

The tie between a market orientation and the success of any organization is illustrated by Peter Drucker's (1973) comment, "To satisfy the customer is the mission and purpose of every business (p. 79)." Customer satisfaction is achieved when superior customer value is delivered by the business. SCM delivers superior customer value by avoiding the suboptimization inherent in non-integrated chains, while simultaneously coordinating value-adding knowledge and activities across the supply chain.

Marketing theory related to the importance and creation of customer value provides a theoretical foundation for this study. The early foundations of customer value-based theory were laid by Alderson (1957) and Drucker (1973), among others. Other important research in this area includes Anderson (1982), Day and Wensley (1988), Dickson (1992), Hunt and Morgan (1995), Kohli and Jaworski (1990), Slater and Narver (1995), and Webster (1992). This study, with its empirical investigation of a relatively new mechanism for maximizing customer value (i.e., SCM knowledge), contributes to this rich literature.

SCM has a number of similarities with the traditional value-based theories found in the marketing literature. Figure 5 illustrates these similarities by comparing Slater's (1997) summary of the marketing literature related to value-based theories with Handfield and Nichols' (1999) recent book on SCM.

Value-based theory (Slater 1997)	**SCM (Handfield and Nichols 1999)**
Turbulent and complex environment	Rapid environmental change
Demanding customers (quality, service, price)	Customer demands (quality, service, price)
New media and distribution channels (Day 1994b)	New forms of inter-organizational relationships
Rapid rate of technological change (Achrol 1991)	Speed of technological change (Hage 1980)
Intense global competition, even in oligopoly markets (Cravens & Shipp 1991)	Global competition
Information technology and knowledge increasingly important sources of competitive advantage (Day 1994a, 1994b; Glazer 1991; Slater & Narver 1995)	Information technology innovations. Explosion in knowledge (Hage 1980)

Figure 5. Similarities Between Value-based Theory and Supply Chain Management

In summary, SCM research has important implications for marketing theory and practice and clearly demands a place in the marketing literature.

Attributes and Benefits of SCM

Although this study does not specifically examine the relationship between SCM and firm performance, some discussion of the proposed benefits of SCM is important in order to understand SCM, including its popularity and importance. Following is a list of the benefits of effective SCM, as proposed in the literature:

- elimination of waste (i.e., non-value added activities) (Houlihan 1987)
- maximization of customer value (Handfield and Nichols 1999)
- increased profitability (Claycomb, Germain, and Dröge 1999; Edvinsson and Sullivan 1996)
- reduced system variance (Flynn, Sakakibara, and Schroeder 1995)
- reduced cycle times and system inventories (Handfield and Nichols 1999; Tan, Kannan, and Handfield 1998)
- better product design (i.e., concurrent design, Hartley 1992)
- happier, more productive workers (Lawrence and Lorsch 1967)

The unique benefits associated with SCM derive from effective coordination and integration across supply chains, including the minimization of suboptimization. The greater the opportunity for suboptimization, the greater the potential benefits of effective SCM implementation. An explanation of this phenomenon is provided by Lee and Billington (1992), who propose the more complex a network of suppliers, manufacturers, and distributors, the more likely the chance of gaining operational efficiencies by attending to shared concerns (e.g., the creation of value). Without the coordination and integration provided by SCM, a sort of entropy results in which subunits of systems optimize their individual functions at the expense of overall system optimization. That is, each subunit operates with variance, and without coordination (i.e., SCM) the individual unit variances tend to have an additive or even multiplicative affect on total system variance. A classic example of this "bullwhip effect" was found at Proctor & Gamble, as reported by Lee, Padmanabhan, and Whang (1997),

> ...not long ago, logistics executives at Procter & Gamble (P&G) examined the order patterns for one of their best-selling products, Pampers. Its sales at retail stores were fluctuating, but the variabilities were certainly not excessive. However, as they examined the distributors' orders, the executives were surprised by the degree of variability. When they looked at P&G's orders of materials to their suppliers, such as 3M, they discovered that the swings were even greater. At first glance, the variabilities did not make sense. While the consumers, in this case, the babies, consumed diapers at a steady rate, the demand order variabilities in the supply chain were amplified as they moved up the supply chain. P&G called this phenomenon the 'bullwhip' effect (p. 93).

This phenomenon was first reported by Forrester (1958), who, using a simulation model, illustrated the large fluctuations in inventories that can result from the combined variances of separate functions within a supply chain.

SCM provides a coordination mechanism that reduces total system variance by allowing, and even encouraging, variance at the subunit level for the sake of optimizing the total system. The system-wide optimization approach of SCM has the potential of benefiting any and all value-adding activities within the supply chain, not only inventory and distribution, but also design, assembly, finance, and services.

Included in SCM's proposed advantages is cycle time reduction. Increasingly, organizations are realizing the need to compete on the basis of time (Handfield and

Nichols 1999). The coordination of product and information flows up and down the supply chain provides the means to make significant reductions in the cycle times involved in moving materials between supply chain members and to the end customer (Handfield and Nichols 1999).

Another interesting suggested but untested benefit of SCM is its motivational affect on individual workers. Lawrence and Lorsch (1967) found that individuals working in organizations well-structured to deal effectively with the organization's tasks had greater feelings of satisfaction and growth than individuals working in organizations that were not well-structured to their tasks. In other words, organizations whose members are able to work within structures designed to assist them in dealing realistically and effectively with their tasks are provided powerful sources of social and psychological satisfaction (Rice 1963). Thus, to the extent that SCM and its attendant organizational structure is effective in allowing workers to deal effectively with their tasks, it may act as a source of social and psychological satisfaction, and a motivational mechanism (White 1963).

Organizational Knowledge

Liebeskind (1996) reports that "... knowledge is arguably the most important asset that firms possess -- a key source of both Ricardian and monopoly rents (p. 93)." In this section, various perspectives of knowledge will be explored in order to derive the concept of SCM knowledge. First, various definitions of knowledge will be reviewed, followed by a look at knowledge from an epistemological perspective. Next, organizational knowledge, information, learning, and absorptive capacity will be reviewed as they relate to SCM knowledge. Finally, the concept of a "knowledge company" and knowledge-based theories of the firm will be discussed. The purpose of this review is to lay a foundation for the definition of a specialized branch of organizational knowledge, SCM knowledge, as a tacit organizational knowledge evidenced by the effective performance of SCM related activities.

Definitions of Knowledge

Waley (1938) provides a translation of the teachings of Confucius, including the following ancient philosophical insight related to knowledge. "The Master said ... shall I teach you what knowledge is? When you know a thing, to recognize that you know it, and when you do not know a thing, to recognize that you do not know it. That is knowledge (p. 91)." The first reaction of most people upon reading such a simple and circular definition might be to dismiss the definition as irrelevant or incomplete. However, given the longstanding and revered status of this great philosopher, it would undoubtedly be much wiser to spend a little time and effort pondering what he meant. Obviously, one purpose of his giving this definition was to provoke additional thought on the part of the reader. Beyond that, Confucius' definition seems to focus on knowledge as a sort of awareness or understanding that goes beyond opinion, to the point of confidence.

Another great philosopher, Plato, provides the following insight: "Science, or knowledge, by itself is knowledge of learning by itself, ... but any special knowledge is of some special thing. Take an example: when the knowledge of building a house came up, it differed from other kinds of knowledge and was called housebuilding (Rouse 1984, p. 238)." Plato's definition clearly suggests the reality and importance of specialized types or branches of knowledge (e.g., SCM knowledge). Like Confucius, Plato did not escape the circularity common among definitions of knowledge (i.e., knowledge is knowing).

Several important researchers have contributed to our understanding of knowledge as applied to organizations and society. Some of the earliest work in this area was done by Scheler (1925), a German philosopher. As translated and explained by Machlup (1962, p.21), Scheler distinguishes three classes of knowledge: *herrschaftswissen* -- knowledge for the sake of action or control (i.e., instrumental knowledge), *bildungswissen* -- knowledge for the sake of non-material culture (i.e., intellectual knowledge), and *erlösungswissen* -- knowledge for the sake of salvation (i.e., spiritual knowledge). Providing a further refinement of knowledge types, Machlup (1962, p. 21,22) himself distinguishes five types of knowledge related to societies or organizations:

> 1. Practical knowledge: useful in a person's work, decisions, and actions. Can be subdivided, according to activities into: (a) Professional knowledge; (b) Business knowledge; (c) Worker's knowledge; (d) Political knowledge; (e) Household knowledge; (f) Other practical knowledge
>
> 2. Intellectual knowledge: Satisfying a person's intellectual curiosity, regarded as part of liberal education, humanistic and scientific learning, general culture; acquired as a rule in active concentration with an appreciation of the existence of open problems and cultural values.
>
> 3. Small-talk and pastime knowledge: Satisfying non-intellectual curiosity or the desire for light entertainment and emotional stimulation, including local gossip, news of crimes and accidents, lights novels, stories, jokes, games, etc.; acquired as a rule in passive relaxation from "serious" pursuits; apt to dull sensitiveness.
>
> 4. Spiritual knowledge: related to a religious knowledge of God and of the ways to the salvation of the soul.

> 5. Unwanted knowledge: outside normal interests, usually accidentally acquired and aimlessly retained.

Although these early researchers provide helpful categorizations of knowledge, laying a foundation for us to claim a type of practical knowledge called SCM knowledge, their work does not bring us closer to a definition of knowledge itself. As has already been shown in the circular definitions given by Plato and Confucius, the problem of defining knowledge has existed as long as the study of knowledge itself. Wittgenstein (1958) pointed out the futility of trying to define knowledge in an exact manner, noting "There is no exact usage of the word knowledge; but we can make up several such usages, which will more or less agree with the ways the word is actually used (p. 27)." Any attempt, therefore, to precisely define knowledge is beyond the scope and intent of this study. Like Von Krogh and Roos (1995), although we lack a precise definition of knowledge we are

> ...content with the idea that human beings know, mainly because knowledge is intimately associated with life and experience. So, as long as we are alive (at least if we are conscious) we come to know new experiences. So, in spite of its circularity: we know that we experience -- that we know (p. 2).

Any further discussion of defining knowledge itself would require a more substantial investigation of existential and philosophical issues (i.e., what is man, body, soul or mind) which is beyond the purposes of this study. Thus, the matter is left as it is, for the moment. Later in this chapter, in Figure 6, the various approaches to knowledge are summarized as they relate to SCM knowledge.

An Epistemological Perspective

The word epistemology comes from the Greek words episteme (knowledge) and logos (theory) which together mean the study or theory of knowledge. Traditionally, epistemology has been considered one of the three main branches in the grand divisions of philosophy. The other two branches are metaphysics and the theory of value. Epistemology is concerned with understanding the origin, nature, and validity of knowledge. It is referred to as theory of knowledge in that it seeks to provide knowledge about knowledge. "Epistemology typically addresses issues like the role of reasoning in knowledge development, the role of sensory perception in knowledge development, types of knowledge, the difference between knowing and believing, the degree of certainty in knowledge, and so on (Von Krogh and Roos 1995, p. 7)."

This study's interest in epistemology relates to SCM knowledge, a specific type of knowledge. According to Von Krogh and Roos (1995), there is a relationship between any specific management (or organizational) issue, such as SCM knowledge, and epistemology or the study of knowledge itself. The relationship between epistemology (i.e., theory) and a specific application (i.e., SCM) is also supported in Goldman's (1986) definition of epistemology in which he proposes that epistemology encompasses

> ...the whole range of efforts to know and to understand the world, including unrefined, workaday practices of the layman as well as the refined, specialized methods of the scientist or scholar. It (epistemology) includes the entire canvas of topics the mind can address: the nature of cosmos, the mathematics of set theory or tensors, the fabric or man-made symbols and culture, and even the simple layout of objects in the immediate environment. The ways that minds do or should deal with these topics, individually or in concert, comprise the province of epistemology (p. 13).

Surely, Goldman's definition provides license to the concepts of organizational knowledge and the more specific knowledge of SCM.

Von Krogh and Roos (1995) noted the twofold purpose of epistemology: one, providing a field of scientific enquiry (i.e., the study of knowledge itself), and the other, better understanding the knowledge development of a specific discipline. It is the latter purpose that is most relevant to this study. That is, this study contributes to epistemological research by providing a better understanding of SCM knowledge development.

Management and organization studies have not paid much attention, thus far, to the fundamental issues of epistemology (Von Krogh and Roos 1995). Knowledge has been taken for granted, often as a decomposable, fuzzy, and substitutable concept, and has been used interchangeably with the concept of information (e.g., Cyert, Kumar, and Williams 1993). Following is a review of some of the key findings of epistemological research related to business and social organizations.

The Cognitivist Epistemology was heavily promoted in the mid-1950s based on the ideas of Simon (1957) and others. The central idea of cognitive science is "representationism," the idea that "the mind has the ability to represent reality in various ways, creating inner representations that partly or fully correspond to the outer world (Von Krogh and Roos, p. 13)." Under cognivist theory, learning is accomplished as the accuracy of representations of the world is improved, which normally takes place through assimilating new experiences (Bruner and Anglin 1973). Cognivists view the human brain as a logic "machine". "The cognivist epistemology ... allows the computer to be understood with the same conceptual system as the brain (Von Krogh and Roos 1995, p.

16)." Indeed, Varela (1992, p. 240) calls artificial intelligence the "literal construal" of the cognivist epistemology. The brain employs logic in its processes of reasoning and embodies logical principles in its physical structure (Varela 1992). Logic becomes the human competence that reveals the truth about observed phenomena. That is, logic is the vehicle for attaining knowledge (Montague 1962). As Spender (1996a) notes, with few exceptions (e.g., Nelson and Winter 1982; Nonaka and Takeuchi 1995: Scherer and Dowling 1995),

> Organizational theorists have constrained their theorizing by adopting a positivist theory (a philosophical doctrine contending that sense perceptions are the only admissible basis of human knowledge and precise thought) of knowledge that takes little account of the millennia of debate about the problematic nature of human knowledge. This naïve neo-Kantian view is that all tenable knowledge (justified true belief) is the result of systematic (scientific) analysis of our sensory experience of a knowable external reality. Knowledge is tested by seeing whether it predicts our experience of that reality (p. 48).

Spender's concern revolves around the argument that organizational theorists have not kept pace with the development of epistemology as it relates to organizations.

The principle criticisms of cognivist epistemology focus on two deficiencies. First, the cognivist perspective demands a sequential rule-based manipulation of symbols, which is inconsistent with the parallel processing seen in biology and assumed to take place in organizations. Second, the cognivist approach suggests that information processing is localized, which would render a system or process inoperable if even a single step or symbol was missing or damaged. The lessons of biology and nature clearly show that organisms are capable of continuing to function (i.e., think) even when damaged or dealing with incomplete information (Varela 1992).

The connectionist epistemology that evolved in the 1970s deals with many of the deficiencies of the cognivist (e.g., positivist) epistemology expressed by Von Krogh and Roos (1995) and Spender (1996a).

The Connectionist Epistemology suggests that, rather than working sequentially, the brain seems to have dynamic global properties in a network of simple components (i.e., neurons) (Von Krogh and Roos 1995). Like the cognivists, the connectionists see information processing as the basic activity of the brain (Wechsler 1992). Environmental information is taken in through the senses and activates various components in the network of components that comprise the brain. However, stimuli come not only from the environment but also from the brain itself. According to Varela, Thompson, and Rosch (1992, p. 96) the behavior of the whole system resembles a cocktail party conversation (between outside and inside) much more than a chain of commands triggered from a central unit.

What does the connectionist epistemology have to contribute to our understanding of organizational knowledge in general and SCM knowledge in particular? The answer is in the well-developed literature on the network approach to interorganizational cooperation (e.g., Jarillo 1988) which focuses on evolving systems, structures, and processes. The connectionist epistemology allows organizations or interorganizational networks to be viewed as networks of information processing components. In a single brain, neurons are the components and the brain is the network. In organizations, individual brains are the components and the organization is the network. In interorganizational networks, individual brains and organizations are the components and the interorganizational relationship is the network. Weick and Roberts' (1993) study of flight crews working together provides one example of the synergy generated when individuals work together in a common cause.

Connectionism contributes to organizational theory by suggesting that units (i.e., individuals and/or groups of individuals), if richly connected, can be encoded with complex patterns of activation and inhibition. In others words, organizations and interorganizational networks may have the ability to absorb and utilize knowledge that goes beyond the knowledge held by the individuals. As Von Krogh and Roos (1995) note, "Connectionists also raise the possibility that mind is located in connections and the weights put on them rather than in entities (p. 27)." This suggests that organizations, networks, and societies retain and use relationship-based knowledge unique to themselves. Thus, the creation of networks and supply chain relationships may lead to the creation of unique supply chain knowledge and competency. This perspective supports the interorganizational (i.e., upstream, internal, and downstream) nature of SCM knowledge which will be further explored later.

A more subtle and rarely touched upon implication of connectionist epistemology lies in two fundamental assumptions, expressed by Von Krogh and Roos (1995): (1) the emergent nature of knowledge, and (2) the historical nature of knowledge. "As seen, previous states in the network, together with new information from the environment, will affect the resulting present knowledge of the organization (p. 25)." In other words, what we learn (i.e., new knowledge) is effected by what we already know. This further implies that knowledge builds on itself and is self-reinforcing.

Autopoiesis describes an even more recent development in epistemology. The concept of autopoietic systems comes from the discipline of neurobiology and is distinct from the mainstream *weltanschauung* (comprehensive worldview or perspective from a specified viewpoint) of cognition. The autopoietic perspective reflects the belief that cognitive activities in organizations are simultaneously open and closed. Von Krogh and Roos (1995, p. 33) note the concept of autopoiesis was originally developed in the field of neuro-biology by the Chilean scientists Humberto Maturana and Francisco Varela, and further developed together with Ricardo Uribe. These researchers sought to better understand the nature of living systems as illustrated by cells and cell reproduction. They recognized that all living systems must share common attributes and they wanted to identify those attributes that qualify a system as 'living'. The answer, they found, lies in self-production. Autopoiesis is derived from the Greek words auto (self) and poiesis (production). Von Krogh and Roos (1995) explain, "The main argument of autopoiesis theory is that living systems are created and recreated in an autonomous, simultaneously open and closed, self-referencing, and observing manner (p. 33)." Based on a theory of autopoietic systems, Vicari (1991) suggests that a firm is indeed a living system (*L'impresa vivente*). In so claiming, Vicari obviously considers the concept and definition of life to extend beyond the discipline of biology, to include human organizations and societies.

Related to organizational knowledge, autopoiesis may lead to the development of a new organizational epistemology and help explain why and how knowledge develops in organizations. Such a discussion is beyond the scope of this study, but is mentioned because it is of related interest. Since its introduction, autopoiesis has evolved into a general systems theory (Luhmann 1987; Van Twist and Schaap 1991; Varela 1979). In the opinion of Von Krogh and Roos (1995), this theory has had an impressive impact in many fields. The development of autopoiesis as applied to organizations and social systems is similar to the main thrust of systems theory thinking in that it sees systems as adapting to their environment, and thus, being ever more open (Buckley 1967). Although still relatively undeveloped, the autopoiesis concept does appear to support the evolution of SCM and its emphasis on interorganizational cooperation and system-wide effectiveness and efficiency.

Another aspect of autopoiesis theory that impacts SCM knowledge is the idea that systems use past experiences to orient themselves in new situations. In other words, previous experience affects new experiences gained. The exciting implication of this insight is that "situation" and "knowledge" may be structurally coupled and co-evolving. Von Krogh and Roos suggest that the interconnection of knowledge and world (i.e., situation) make it virtually impossible to say which started first, which helps explain why definitions of knowledge inevitably become circular.

Of final interest, one spin-off of autopoiesis theory is the idea that "The language we use influences how we experience our world and thus how we know our world (Sorri and Gill 1989, p. 71)." Von Krogh and Roos (1995, p. 95) cite the example of Eskimos, who use some thirty words to describe different kinds of snow. Because the Eskimos' world is made of snow, a language has developed to express their unique knowledge. SCM knowledge has also produced a unique language to express that knowledge. Words such as networks, supply chains, value-added, cross-functional, JIT, SCM, co-design, etc., have only recently emerged to express the new knowledge associated with SCM.

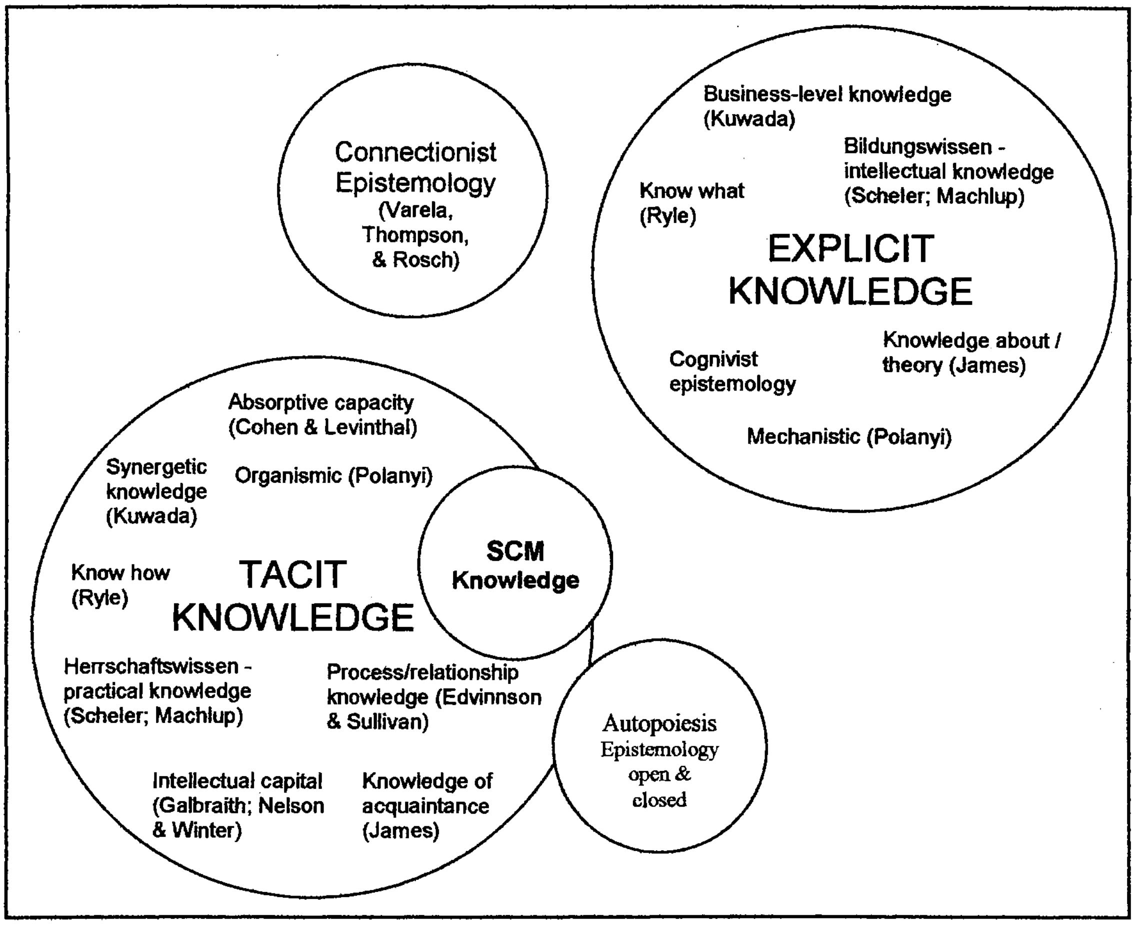

Figure 6. The Interrelationships of Knowledge Types

Organizational Learning and Knowledge

The close relationship and interconnectedness between knowledge and learning justifies discussing them together in this section. The redundancy often found in definitions of learning and knowledge also suggests that they be jointly discussed.

A basic premise of SCM knowledge, or any social knowledge, is that learning can take place, and knowledge held, within a group or system, not just within individual human beings. This being the case, the previous discussions of knowledge must be viewed, not only from the perspective of individual knowledge, but also from the perspectives of group, organization, and supply chain knowledge. Von Krogh and Roos

(1995) propose that organizational knowledge resides in both the individual organization member and in the relations among organization members. Lukas, Hult, and Ferrell (1996) note,

> Organizational learning is an organizational process rather than an individual process. Although individuals are the agents through whom the learning takes place, the process of learning is influenced by a much broader set of social, political, and structural variables. It involves sharing of knowledge, beliefs, or assumptions among individuals (p. 234).

Along this same vein, Hedberg (1981) writes,

> Although organizational learning occurs through individuals, it would be a mistake to conclude that organizational learning is nothing but the cumulative result of their members' learning. Organizations do not have brains, but they have cognitive systems and memories. As individuals develop their personalities, personal habits, and beliefs over time, organizations develop world views and ideologies. Members come and go, and leadership changes, but organizations' memories preserve certain behaviors, mental maps, norms and values over time (p. 6).

The existence of organizational knowledge, or knowledge unique to an organization, suggests that networks, supply chains, and other groups, even ones that cross organizational boundaries, are capable of learning and knowledge. However, the problematic nature of studying interorganizational knowledge combined with the relative ease of studying organizational knowledge confines practically all research to autonomous organizations and groups. In this study, for example, the logical choice for observing SCM knowledge is at the organization level rather than across an entire supply chain, even though some unique knowledge may exist interorganizationally.

<u>Organizational Learning</u> has been defined in a number of different ways and often in the same circular manner in which knowledge is defined. Miller (1996) suggests the definition of learning remains somewhat obscure due to the process being described in so many different ways in the literature. Nevertheless, there is widespread acceptance that

organizations do learn and that this learning process has an affect on the performance of the organization (Fiol and Lyles 1985). In a review of organizational learning, Fiol and Lyles (1985, p.803) summarize existing definitions of organizational learning as follows:

1. New insights or knowledge (Argyris and Schön 1978; Hedberg 1981).
2. New structures (Chandler 1962).
3. New systems (Jelinek,1979; Miles 1982).
4. Actions (Cyert and March 1963; Miller and Friesen 1980).
5. Some combination of the above (Bartunek 1984; Shrivastava and Mitroff 1982).

The commonality in these various definitions is in the importance of alignment or matching the organization and its structure to the demands of the environment. Theorists such as Chandler (1962), Katz and Kahn (1966), and Thompson (1967) propose that the ultimate criterion of organizational performance is long term survival and growth. Long term survival and growth is achieved as organizations align with their environments (Barnard 1938; Lawrence and Dyer 1983; Lawrence and Lorsch 1967; Thompson 1967), either by changing their structure, by influencing their environment, or both. In the end, the key to strategic management becomes an alignment between the organization and its environment that maintains the competitiveness and the survival of the firm over the long run (Hambrick 1983). Learning and knowledge are the mechanisms that provide this alignment.

The works of Chakravarthy (1982), Chandler (1962), Cyert and March (1963), Hambrick (1983), Miles and Snow (1978), and Miller and Friesen (1980) support the idea that firms must learn in order to survive. In fact, Chakravarthy (1982) argues that adaptation is the essence of strategic management because it is the means by which organizations can deal with environmental change and it involves a continuous process of strategic decision making. It is also suggested that organizations' learning skills and abilities increase as they successfully learn and adjust to changing environmental conditions over time (Miles 1982). These views support the importance of knowledge-based practices such as JIT and SCM for the long term growth and survival of firms.

Simon (1969) defined organizational learning as increased insights and successful restructuring of organizational problems, as reflected in an organization's structure and performance. An important implication of this perspective, as relates to this study, is that organizational knowledge and structure are related and that organizational knowledge is reflected in organizational actions.

The link between knowledge and action is further explored by Slater and Narver (1995, p.63), who write,

> At its most basic level, organizational learning is the development of new knowledge or insights that have the potential to influence behavior (e.g., Fiol and Lyles 1985; Huber 1991; Simon 1969; Sinkula 1994). Presumably, learning facilitates behavior change that leads to improved performance (Fiol and Lyles 1985; Garvin 1993; Senge 1990; Sinkula 1994).

Slater and Narver (1995, p.71) call for further research into learning and knowledge as they relate to behavior and structure. They suggest that all businesses competing in dynamic and turbulent environments must pursue the processes of learning,

> Given the limited empirical evidence regarding organizational learning, the assessment of its benefits and the development of a clear understanding of the processes of organizational learning and the management practices that facilitate or hinder organizational learning should be a high priority (e.g., Marketing Science Institute, 1993).

The result of learning is knowledge. Thus, it may be argued that whatever is to be learned about organizational learning also appertains directly or indirectly to organizational knowledge. As with Huber (1991), the definition of SCM knowledge developed in this study focuses on "measurable activities that are done intentionally (p. 89)." In arguing for the study of organizational knowledge versus organizational learning, Huber (1991) further argues, "Learning (alone) does not always increase the learner's effectiveness, or even potential effectiveness. Learning does not always lead to veridical knowledge. Entities can incorrectly learn, and they can correctly learn that which is incorrect (p. 89)." Following Huber's advice, this study focuses on SCM knowledge rather than SCM learning.

Organizational Knowledge can be divided into two distinct roots (Spender 1996a). The first, supported by the work of Nonaka and Takeuchi (1995) and Drucker (1985, 1988), establishes organizational knowledge as a strategic factor of production distinguished from the traditional factors of production: labor, land and capital. This perspective of organizational knowledge suggests that management focus on the production, acquisition, movement, retention and application of organizational knowledge. The second root of organizational knowledge is expressed in James' (1950) argument that human knowledge comes in two types: "knowledge about" and "knowledge of acquaintance". Spender (1996a) clarifies the distinction between these knowledge types as follows:

> Though these terms are clumsy in English, corresponding somewhat to 'in theory' and 'practical common sense,' the distinction is reflected in most Romance languages, e.g. wissen vs. kennen, savoir vs. connaître. In the same vein, Ryle is often quoted as distinguishing between 'know what' and 'know-how.' James argued that the interaction of the two types of knowledge is the pragmatist's notion of the scientific method. While experience provides immediate 'knowledge of acquaintance,' 'knowledge about' is the result of the systematic thought that eliminates the subjective and contextual contingencies of experience and extracts the principles that lie behind the 'knowledge of acquaintance.' Science is the process of 'purification' which renders knowledge of acquaintance into knowledge about (p. 46).

Spender (1996a) further suggests, "The multitype epistemology which has had most impact on our field, as well as on Penrose (1959), can be framed in terms of Polanyi's (1962, 1967) distinction between explicit and implicit knowledge (p. 50)." A number of learning theorists (Grant 1996a, 1996b; Inkpen 1998; Johnson 1998; Nonaka 1994; Nonaka and Takeuchi 1995; Spender 1996a, 1996b) draw on Polanyi's (1962, 1967) work and suggest that for firms' knowledge comes in two general forms, explicit and tacit. Polanyi's distinction of explicit and tacit knowledge is introduced into the management literature by Nelson and Winter (1982) in their evolutionary theory of the firm.

Spender (1996a) argues that Nelson and Winter's treatment parallels the later analyses of Fuller (1988) and Plotkin (1994) who, as sociologist and psychobiologist respectively, were not aware of Nelson and Winter's earlier work. Referring to these earlier researchers, Spender (1996a) writes, "All argue that social organizations, firms, species and societies evolve by adapting the body of knowledge shared by their members, and that much of the process takes place at the tacit level (p. 50)."

Explicit knowledge is factual and objective and is described as discrete or digital (Grant 1996a; Johnson 1998; Spender 1996b). Explicit knowledge is easily articulated and transmitted with minimal loss. Indeed, some authors use the term articulated knowledge in place of explicit knowledge (Hedlund 1994; Winter 1987). Johnson (1998) notes that explicit knowledge is declarative in that it involves knowing about. Explicit knowledge is found in databanks, manuals, and written procedures (e.g., Grant and Baden-Fuller 1995; Nonaka 1994; Spender 1996a). Explicit knowledge is like "knowledge about" in its abstractness, while tacit knowledge is associated with experience.

Tacit knowledge is relatively difficult to formalize and communicate. It is based on Polanyi's (1967) notion that "we can know more than we can tell (p. 4)." It is characterized as being unarticulated, subjective, and context specific (Johnson 1998). Spender (1996a) suggests that tacit knowledge is knowledge that has not yet been abstracted from practice, although Polanyi (1967) would argue that there is no knowledge that does not retain a core tacit dimension. Tacit knowledge is relatively difficult to codify as compared to explicit knowledge. If codification of tacit knowledge is somehow possible or forced, doing so often involves significant knowledge loss (Grant 1996a; Spender 1996a; Winter 1987). Tacit knowledge involves "knowing how", as opposed to explicit knowledge which involves "knowing about". All of these characteristics reinforce the argument that tacit knowledge is not easily transferred between people or organizations (Johnson 1998; Spender 1996a).

Spender (1996a) further points out that

> Polanyi's notion of the tacit is richer than mere knowledge of acquaintance because it brings in a post-Freudian psychological dimension, reaching beyond conscious knowledge into the sub and preconscious modes of knowing. His intent was to criticize the positivist norm of doing good science, that one should interact only the explicitly rationalist and empiricist traditions by formulating logical hypotheses and doing repeatable tests. He argued that scientific creativity comes primarily from deep immersion in the phenomena to be explained, for that alone gives rise to intuitions about how to begin the interaction. For Polanyi science was a process of explicating the tacit intuitive understanding that was driven by the subconscious learning of the focused scientist (p. 50).

Although SCM knowledge arguably contains both explicit and tacit elements, it is the tacit elements that are most interesting because of their idiosyncratic nature and link to application and routines. Nelson and Winter (1982) suggest that a firm's application of better routines is an indication of increased knowledge or learning. Further, they state,

> Social types of knowledge are either publicly available or collective and embedded in the firm's routines, norms and culture. Since the latter are generated internally and remain 'of the firm,' they give rise to the economic rents associated with effective collective practice which we labeled 'Penrose rents,' and different strategies are required for their maximization. If, as we have suggested, collective knowledge is the most secure and strategically significant kind of organizational knowledge, then we should seek an explanation of what it is about firms that enables collective learning to take place, and collective knowledge to be retained and applied better than under other institutional arrangements (p. 52).

Based on these arguments, this study proposes that SCM knowledge is a tacit knowledge held within an organization (e.g., supply chain) evidenced by the performance of SCM related activities.

Strategic Learning, another area of organizational learning and knowledge, deserves some attention before concluding this discussion. Kuwada (1998) introduces the concept of strategic learning to explain the long-run dynamics of strategic behaviors. Strategic learning is organizational learning that specifically and directly helps an organization align itself with the environment in order to secure its long term survival (i.e., performance and growth). Because SCM knowledge results in better organizational alignment with knowledge-rich environments, it is proposed that SCM knowledge is one result of strategic learning. Thus, a brief review of the literature is relevant.

Within strategic learning, Kuwada (1998) identifies two types of strategic knowledge: business-level knowledge and synergetic knowledge (see also Asaba and Kuwada 1989). Although both types of knowledge are thought to be critical to the survival and welfare of firms, from a strategic perspective, synergetic knowledge is believed to be more important because it is idiosyncratic to the firm, difficult to imitate, and provides and sustains the firm's competitive advantage. Synergetic knowledge shapes the core competence of the firm (Prahalad and Hamel 1990; Teece, Pisano, & Shuen 1990). Synergetic knowledge in comparable to tacit knowledge and may be considered a subset of tacit knowledge. Business-level knowledge, on the other hand, is considered the same as explicit knowledge (see Figure 6). Kuwada emphasizes that the value of synergetic (i.e., tacit) knowledge lies in its idiosyncratic nature and its difficulty to imitate.

In summary, knowledge resides not only in the individual, but also in "the small group, the organization, and the interorganizational domain (Hedlund 1994, p. 75)." This study lays the foundation for distinguishing SCM knowledge as a specific and meaningful type of organizational knowledge. Before closing this section, and without pretense of a thorough review, other recent examples of potentially relevant research include Stiglitz (1987) on localized knowledge; Porac, Thomas and Baden-Fuller (1988) on cognitive groups; Stubbart (1989) and others on organizational cognition; March (1991) on individual vs. group learning; Seely-Brown and Duguid (1991) on the communal context of learning; and Wolfe (1991) on mind as a social category. Finally, a fitting description of the goal of organizational learning and knowledge is found in Garvin's (1993) statement that firms can generate an endless cycle of continuous improvement by "creating, acquiring, and transferring knowledge, and [by] ... modifying [their] ... behavior to reflect new knowledge and insights (p. 80)."

SCM Knowledge as Absorptive Capacity

The concept of "absorptive capacity" is developed by Cohen and Levinthal (1990) and is closely related to organizational knowledge. Because various aspects of this paradigm are particularly supportive of the purposes of this study, a review of this literature is included. Cohen and Levinthal (1990) propose that "the ability to evaluate and utilize outside knowledge is largely a function of the level of prior related knowledge (p. 128)." Although not unique in their mention of the self-reinforcing effects of knowledge, Cohen and Levinthal's research is unique in the emphasis placed on this self-reinforcing mechanism which they call "absorptive capacity". Absorptive capacity itself may be classed as a tacit knowledge (i.e., know how) since it is specifically defined as "an ability" (Cohen and Levinthal 1990, p. 128). The logic of absorptive capacity suggests that prior related knowledge enables "an ability to recognize the value of new information, assimilate it, and apply it to commercial ends (Cohen and Levinthal 1990, p. 128)."

Based on the absorptive capacity paradigm, this study suggests that organizations with established JIT and/or SCM knowledge are relatively better able to recognize the value of SCM knowledge, assimilate it, and apply it to commercial ends. Bower and Hilgard's (1981) research in the area of memory development suggests that accumulated prior knowledge increases the ability to store new knowledge in memory (i.e., acquisition of knowledge), as well as the ability to recall and use that knowledge. With respect to the acquisition of knowledge, Bower and Hilgard (1981) suggest that "memory development is self-reinforcing in that the more objects, patterns and concepts that are stored in memory, the more readily is new information about these constructs acquired and the more facile is the individual in using them in new settings (p. 424)."

As should be expected with any tacit knowledge, the development of absorptive capacity demands an intensity of effort beyond mere exposure to relevant information or knowledge. Lindsay and Norman (1977) note that "the more deeply the material is processed -- the more effort used, the more processing makes use of associations between the items to be learned and knowledge already in the memory -- the better will be the later retrieval of the item (p. 355)." The implication here for SCM knowledge is enormous. That is, the greater a firm's level of SCM knowledge (i.e., skill or ability), the greater their ability to absorb more SCM-related knowledge.

The tacit knowledge component of absorptive capacity is idiosyncratic and linked to activities. The challenge is to coordinate and integrate this knowledge within the firm and across the supply chain. As Cohen and Levinthal (1990) note,

> An organization's absorptive capacity does not simply depend on the organization's direct interface with the external environment. It also depends on transfers of knowledge across and within subunits that may be quite removed from the original point of entry. Thus, to understand the sources of a firm's absorptive capacity, we focus on the structure of communication between the external environment and the organization, as well as among the subunits of the organization, and also on the character and distribution of expertise within the organization (p. 131).

Following this advise, this study focuses not only on the internal activities of organizations, but also on interorganizational (i.e., upstream and downstream) SCM activities, relationships, and communications aimed at coordinating and integrating expertise (i.e., specialist knowledge) across the supply chain.

Another fascinating aspect of absorptive capacity supportive of this study is that knowledge critical to the organization may be found not only within the firm, but also throughout the network or supply chain. This concept is a basic premise of SCM and illustrates the commonality between absorptive capacity and SCM concepts. Examples of critical knowledge that may only be found outside an organization include: who knows what, who can help with what problem, and who can best exploit new information. SCM serves as a mechanism for coordinating this diverse knowledge. Recognizing the importance of coordinating knowledge and expertise from beyond the organization, Von Hippel (1988) recommend that organizations maintain close relationships with downstream customers and upstream suppliers. Cohen and Levinthal (1990) further note, "To the extent that an organization develops a broad and active network of internal and external relationships, individuals' awareness of other's capabilities and knowledge will be strengthened (p. 134)."

The Knowledge Company

Some of the earliest references to knowledge as a characteristic critical to a firm's existence and success come from Hage (1980). Building on previous research on interorganizational relationships by Negandhi (1971, 1975) and on exchange relationships by Levine and White (1961), Hage (1980) surmises that the purpose of interorganizational relationships and the nature of exchanges is often the obtaining of scarce knowledge resources. Hage's earlier work with Aiken (Aiken and Hage 1966) also suggests organizations develop resource interdependencies through their relationships and exchanges. Although resource theory originally focused on the scarcity of financial resources as an incentive for organizations to cooperate, it is knowledge resources that will provide the greatest incentive for interorganizational cooperation in the future.

Once the existence of knowledge resources are recognized, and the scarcity of these resources understood, then it logically follows that firms will compete for existing knowledge resources. Hage (1980) suggests that competition for knowledge provides a partial explanation for the explosive growth of knowledge. He reasons that as firms compete for knowledge resources (i.e., innovation), knowledge grows at an increasing rate. Simply stated, necessity is the mother of invention. Thus, the growth of knowledge becomes the "most likely source of change .... which reduces demand, shortens product life, and expands task scope (Hage 1980, p. 464)."

Hage (1980) further notes, "This [the growth of knowledge] is propelling us into post-industrial society and is nonreversible ... knowledge or technological intensity, like time, grows inexorably (p. 469)." An interesting extrapolation of this reasoning is that knowledge, because of its continuous growth relative to other variables, must naturally increase in significance over time and eventually dominate the system (Landes 1969). Although there is not yet empirical evidence to suggest the knowledge variable is currently dominating the system, this study provides a valuable milestone on the path of organizational knowledge research against which to plot the future growth of knowledge.

The suggestion that knowledge is, or is becoming, the resource of most value to organizations may seem almost blasphemous in light of its relatively recent debut in the business literature. After all, it has only been in the last century that mass literacy has occurred in a few countries. Bell (1973) notes that it is in countries in which the majority have received a college education where we would expect to witness the more dramatic effects of the growth of knowledge. Indeed, the social/cultural context should be considered in any study involving organizational knowledge.

Hage (1980) emphasizes two critical impacts of the growth of knowledge on societies and organizations. First, the growth of knowledge impacts organizations *via* the labor input required to operate the firm. The growth of knowledge makes activities increasingly more complex and drives a shift from labor to machines, from unskilled to skilled, and from skilled to professional. Hage (1980) further notes, "In this sense one can speak of a society growing more complex as its knowledge base grows (p. 473)." Secondly, these changes drive a variety of occupational specialties leading to structural differentiation. Complex tasks, impossible for individuals to handle, are handled by teams of specialists. New knowledge unabsorbable by current specialists requires the creation and development of new specialties and the education and training and new specialists. Although Hage suggests this trend may be mitigated by culture, the evidence of this remains unfound and the tidal wave of knowledge seems to make a generalist philosophy tenable in the long term. The growth of knowledge further implies that even as tasks becomes more differentiated, they get bigger at the same time. Hage (1980) proposes that the larger the knowledge base of a society

> ...the larger the task scope of the average organization and the more emphasis on change and quality as goals. The larger the task scope of the average organization and the greater the emphasis on change and quality as goals, the more the growth in the knowledge base of the society (p. 473).

In addition to the direct effects of the growth of knowledge on the inputs and structure of organizations, the growth of knowledge also impacts the performances and outputs of an organization. Hage (1980) argues that an educated, professionally oriented population "is likely to prefer quality and to be more oriented towards change (p. 473)." Managerially, this equates to the following potential changes in the organization's outputs: greater customization of products, more options, more features, more models, more new products and services and at faster rates, all with higher quality.

Acceptance of Hage's proposals suggests that all organizations and societies are being caught up in a never ending cycle of increasing knowledge and complexity. As a guideline, Hage (1980, p.474) suggests this condition will most likely prevail in societies or organizations in which 50% or more of the labor force have college diplomas (i.e., at least 16 years of education) and where about 10% of the GNP is spent on research of all kinds.

Once the cycle of knowledge is initiated and the Pandora's box opened, the search for new knowledge never ends. Each problem solved generates two new ones. Each incremental improvement in quality increases the recognition of how much more improvement is possible. There is a never ending cycle of faster and faster product development (Mansfield 1968), better and better quality, and lower and lower cost. According to Hage (1980),

> We can now predict the evolution of organizational forms in the United States. As more and more sectors, public and private, become technologically intensive, there will be a greater and greater movement towards the organic-professional and the mixed mechanical-organic (p. 475).

The paradigm of a knowledge company established by Hage (1980) and others is supported by the more recent work of Spender (1996a), Nonaka and Takeuchi (1995), and Drucker (1985, 1988). The paradigm suggests that organizational knowledge is a strategic factor of production distinguished from the traditional factors of production (i.e., labor, land and capital). Edvinsson and Sullivan (1996) define intellectual capital as a stock of focused, organized information or knowledge that the organization can use for productive purposes. Proponents of intellectual capital argue that a company's ability to leverage their knowledge is key to productivity and competitiveness. Indeed, Edvinsson and Sullivan (1996) define the "knowledge company" as a firm that effectively uses their knowledge to create and maintain competitive advantage. The term "intellectual capital" is attributed to the economist John Kenneth Galbraith, who first used the term in a letter he wrote to economist Michael Kalecki in 1969 (Feiwel 1975). According to Edvinsson and Sullivan (1996), intellectual capital is based more on knowledge-based activities (i.e., tacit knowledge) than on academic intellectualism with regard to the term "intellectual".

Edvinsson and Sullivan (1996) also support the concept of organizational knowledge or collective intelligence (all members of a group or organization being aware of, and having access to, all relevant knowledge). Although collective intelligence may be relevant to small groups, more sophisticated information sharing techniques are necessary as groups increase in size, diversity, and number of locations. Sophisticated information systems are also a prerequisite to effective SCM (Handfield and Nichols 1999).

Similar to the previous review of organizational knowledge, Edvinnson and Sullivan's (1996) discussion of business knowledge is based on a distinction between codified (i.e., explicit) knowledge and tacit knowledge (i.e., know-how). They affirm the importance of tacit knowledge based on its idiosyncratic nature and its action orientation. Examples of important branches of tacit knowledge include various know-how or skills, process knowledge, and relationship knowledge. These tacit knowledges are more readily converted into value than codified or explicit knowledge (Edvinsson and Sullivan 1996). Based on this discussion, it is easy to see that SCM knowledge includes important tacit knowledge components, relationship knowledge being a prime example.

A Knowledge-based Theory of the Firm

Hage (1980) notes, "it is the gaining of resources that has the most direct impact on organizations beyond supply and demand (p. 380)." Since the source of differentiation and competitive advantage among firms lies more in its intangible resources than in the tangible, Hage considers knowledge to be a key resource -- one that has significant influence on the choice of organizational form. In other words, Hage suggests that knowledge can predict structure.

Spender (1996a, 1996b) and Grant (1996a, 1996b), building on the earlier work of Hage and others, establish the foundation of a knowledge-based theory of the firm. Spender (1996a) traces the roots of his knowledge-based theory to epistemological foundations established by Knight (1921) and Machlup (1980). Spender (1996a) refers to Simon's (1957) classic critique of economic theory, Penrose's (1959) theory of the growth of the firm, Selznick's (1957) notion of distinctive competence, Chamberlin's (1933) theory of monopolistic competition, Hayek's (1945) theory of markets, and Barnard's (1938) definition of executive activity. Recent proponents of knowledge-based theory include Nelson and Winter (1982), and Baden-Fuller and Pitt (1996).

Grant's (1996b) work on a knowledge-based theory was sparked by the general need for a "multipurpose theory of the firm (p. 109)." Grant notes that any theory of the firm should be capable of answering basic questions associated with why firms exist at all. Like Spender, Grant traces the evolution of knowledge-based theory to the early work of Knight (1921), who explain the firm in terms of optimal risk allocation in the face of individuals' differential risk preferences. Grant argues it was a dissatisfaction with Knight's explanation of the firm that encouraged the development of transaction cost theory with its focus on the relative efficiency of hierarchies versus markets (Coase 1937; Williamson 1975). Grant (1996b) cites other attempts at integrating economics and organizational approaches to the theory of the firm, including Cyert and March's (1963) behavioral theory of the firm and Nelson and Winter's (1982) evolutionary theory of the firm.

Both Spender (1996a) and Grant (1996b) readily accept the contribution of strategic management to the development of a resource-based theory of the firm. Specifically, Grant (1996b) notes,

> The resource-based view of the firm is less a theory of firm structure and behavior as an attempt to explain and predict why some firms are able to establish positions of sustainable competitive advantage and, in so doing, earn superior returns. The resource-based view perceives the firm as a unique bundle of idiosyncratic resources and capabilities where the primary task of management is to maximize value through the optimal deployment of existing resources and capabilities, while developing the firm's resource base for the future (p. 110).

Resource theory suggests that firms obtain specific resources, competencies, and capabilities in order to strategically position themselves in markets and environments (Wernerfelt 1984). Any resource capable of leading a firm to competitive advantage must be scarce, valuable, and reasonably durable (Barney 1991). Rumelt (1987) suggests that such resources are unlikely to be available from others except under terms that strip them of the value or economic rent they might otherwise be capable of generating.

Given the assumption that markets are reasonably efficient at making information (i.e., explicit knowledge) widely available, it logically follows that resources capable of generating sustainable rent streams must necessarily develop or be created within the firm itself. Adding to this argument, Spender writes,

> Since the origin of all tangible resources lies outside the firm, it follows that competitive advantage is more likely to arise from the intangible firm-specific knowledge which enables it to add value to the incoming factors of production in a relatively unique manner. Thus it is the firm's knowledge, and its ability to generate knowledge, that lies at the core of a more epistemologically sound theory of the firm (1996a, p. 46).

Spender (1996a) further suggests that firms be viewed as governance structures or a "nexus of contracts" (Williamson 1990) in which incoming factors of production are merged, synthesized, and transformed into higher-value products and services. This view contrasts somewhat with earlier theories which view the firm as a purely homogenous production function or a bundle of tangible productive resources. Spender (1996a) refers to the intangible knowledge possessed by a firm (i.e., the knowledge applied by the firm's members in value-adding processes) as the key to the generation of rents (i.e., creation of competitive advantage). This is the locus of the all-important "wedge" referred to by Penrose (1959).

Regarding the evolution of a knowledge-based theory from resource-based theory, Grant (1996b) confirms, "to the extent that it [knowledge-based theory] focuses upon knowledge as the most strategically important of the firm's resources, it is an outgrowth of the resource-based view (p. 110)." However, Grant (1996b) points out that knowledge is not unique to resource-based theory. Knowledge, he argues, is central to several other quite distinct research streams including organizational learning, the management of technology, and managerial cognition. Grant's (1996b) concern in developing a knowledge-based theory of the firm is that such a theory address fundamental concerns, "notably the nature of coordination within the firm, organizational structure, the role of management and the allocation of decision-making rights, determinants of firm boundaries, and the theory of innovation (p. 110)." Grant further suggests that resource-based theory inadequately addresses these issues and that a new theory is needed (i.e., a knowledge-based theory of the firm) (Grant 1996b).

One positive aspect of knowledge-based theory is that it attempts to provide a more epistemologically sound theory of the firm. This naturally necessitates some rationalization of knowledge itself, as it relates to the firm. Regarding this problem, Grant (1996b) notes,

> What is knowledge? Since this question has intrigued some of the world's greatest thinkers from Plato to Popper (1969) without the emergence of a clear consensus, this is not an arena in which I choose to compete. In terms of defining knowledge, all I offer beyond the simple tautology of 'that which is known' is the recognition that there are many types of knowledge relevant to the firm (p. 110).

Grant further refers to Machlup's (1980) five classes of knowledge including practical knowledge, intellectual knowledge (embracing scientific, humanistic, and cultural knowledge), pastime knowledge (news, gossip, stories, and the like), spiritual knowledge, and unwanted knowledge. Machlup (1980) also distinguished 13 different "elements of knowing" including being acquainted with, being familiar with, being aware of, remembering, recollecting, recognizing, distinguishing, understanding, interpreting, being able to explain, being able to demonstrate, being able to talk about, and being able to perform.

For the purposes of developing a theory of the firm, Grant (1996b) attempts to establish those characteristics of knowledge which have critical implications for management. His interpretation of the literature on the analysis and management of knowledge pointed to the following characteristics as "pertinent to the utilization of knowledge within the firm to create value (p. 111)." These characteristics are transferability, capacity for aggregation, and appropriability.

Transferability - Grant (1996b) states,

> The resource-based view of the firm recognizes the transferability of a firm's resources and capabilities as a critical determinant of their capacity to confer sustainable competitive advantage (Barney 1986). With regard to knowledge, the issue of transferability is important, not only between firms, but even more critically, within the firm (p. 111).

The distinctions already mentioned between explicit (knowing what) vs. implicit (knowing how) knowledge are important considerations in regard to transferability. Consistent with previous discussion, Grant identifies knowing how with tacit knowledge, and knowing about facts and theories with explicit knowledge. Grant (1996b) notes,

> The critical distinction between the two lies in transferability and the mechanisms for transfer across individuals, across space, and across time. Explicit knowledge is revealed by its communication. This ease of communication is its fundamental property. Indeed information has traditionally been viewed by economists as being a public good - once created it can be consumed by additional users at close to zero marginal cost. Tacit knowledge is revealed through its application and acquired through practice, its transfer between people is slow, costly, and uncertain (p. 111).

As already suggested, SCM knowledge is a tacit knowledge. The difficulty in transferring tacit knowledge has both advantages and disadvantages. An advantage of the difficulty in transferring tacit knowledge is that it makes imitation difficult, thus rewarding firms with competence in tacit knowledge components. The disadvantage is that, even within a firm, transfer of tacit knowledge (i.e., components of SCM knowledge) can be slow and requires practice. Another advantage of tacit knowledge related to this study is that it is revealed through its application. This suggests that tacit knowledge (e.g., SCM knowledge) can be measured and studied by observing the activities associated with that knowledge.

Capacity for Aggregation refers to the characteristic of knowledge that allows it to be absorbed and utilized meaningful ways. This implies that the knowledge to be aggregated somehow fits into the existing schema of knowledge possessed and utilized by the firm. In accordance with Cohen and Levinthal's (1990) concept of absorptive capacity, existing knowledge plays a critical role in individuals' and organizations' abilities to assimilate new knowledge. Organizations already skilled at learning and absorbing new knowledge are also better able to take advantage of new knowledge. One example is that firms skilled at JIT are better able to absorb new SCM knowledge than are firms that are unfamiliar with JIT knowledge. The "additivity" or similarity between existing and new knowledge is key to the capacity for aggregation. One sign of potential additivity is a common language. Here again, the similarity between JIT and SCM makes them a good example. The power of modern information technology, a key to effective SCM implementation (Handfield and Nichols 1999), lies in its effectiveness in providing a common and accessible language.

Appropriability refers to the capability of a resource (e.g., knowledge) to provide its owner with a return equal to the value created by that resource (Levin et al. 1987; Teece 1987). Grant (1996b) notes that knowledge is a resource subject to uniquely complex problems of appropriability. Tacit knowledge is not directly appropriable because it cannot be directly transferred. However, tacit knowledge can be appropriated through its application to productive activity. The problem is the difficulty in assigning a specific value to the tacit knowledge asset. On the other hand, explicit knowledge has even greater problems in this regard, as Grant (1996b) notes:

> Explicit knowledge suffers from two key problems of appropriability: first, as a public or nonrivalrous good, anyone who acquires it can resell without losing it (Arrow 1984); second, the mere act of marketing knowledge makes it available to potential buyers (Arrow 1971). Thus, except for patents and copyrights where knowledge owners are protected by legally established property rights, knowledge is generally inappropriable by means of market transactions (p. 111).

Grant further notes that although most explicit and tacit knowledge is stored within individuals it is created within the firm and is firm specific. Again, this creates a situation in which the value of organizational knowledge is difficult to assess, even though that value may be high. Further, this creates difficulties regarding the allocation of the returns of knowledge and achieving optimal investment in new knowledge (Rosen 1991).

Fundamental to a knowledge-based theory of the firm is the assumption that knowledge is the critical input in production and the primary source of value. Indeed, according to Grant (1996b),

> If we were to resurrect a single-factor theory of value in the tradition of the classical economists' labor theory of value or the French Physiocrats land-based theory of value, then the only defensible approach would be a knowledge-based theory of value, on the grounds that all human productivity is knowledge dependent, and machines are simply embodiments of knowledge (p. 112).

It has been suggested that firms exist because of fundamental asymmetry in the economics of knowledge (Demsetz 1991). That is, knowledge acquisition requires greater specialization than knowledge utilization. Grant (1996b) notes,

> Hence, production requires the coordinated efforts of individual specialists who possess many different types of knowledge. Yet markets are unable to undertake this coordinating role because of their failure in the face of (a) the immobility of tacit knowledge and (b) the risk of expropriation of explicit knowledge by the potential buyer. Hence, firms exist as institutions for producing goods and services because they can create conditions under which multiple individuals can integrate their specialist knowledge (p. 112).

Based on this argument, this study proposes that SCM knowledge is a mechanism to integrate the specialist knowledge of individuals within the firm and across the supply chain, thus supporting the basic purpose and existence of an organization. Defining the role of the firm as that of a knowledge-integrating institution is certainly different from the view generally emphasized in the literature. Most research into organizational learning (Huber 1991; Levitt and March 1988) and the knowledge-based view of the firm (Nonaka 1991, 1994; Spender 1989) focuses on the acquisition and creation of organizational knowledge rather than on the integration of that knowledge. Spender (1989) defines the organization as, "in essence, a body of knowledge about the organization's circumstances, resources, causal mechanisms, objectives, attitudes, policies, and so forth (p. 185)." Grant's (1996b) approach is distinguished by the assumption that "the primary role of firms is the application of existing knowledge to the production of goods and services (p. 112)."

Consistent with the assumptions of this study, a knowledge-based view of the firm allows us to perceive interdependence (i.e., coordination of specialists) as an "element of organizational design and the subject of managerial choice rather than exogenously driven by the prevailing production technology (Grant 1996b, p. 114)." Grant specifically notes that the key issue or challenge of firms from a knowledge-based perspective is being able to devise mechanisms for integrating specialized knowledge.

Consistent with Grant's advise, this study defines SCM knowledge as a mechanism designed to integrate specialist knowledge throughout the supply chain with the objective of maximizing the value delivered to the end customer.

Finally, Grant (1996b) views organizational capability as the "outcome of knowledge integration (p. 116)," and suggests that firms able to effectively integrate a broad range of specialist knowledge have a competitive advantage over those less capable. The concept of organizational capability (i.e., knowledge integration competence) supports the proposition, untested in this study, that SCM knowledge is related to firm performance and competitive advantage.

Practical Knowledge

Von Krogh and Roos (1996) conclude their study of organizational knowledge with a definition of the practical meaning of knowledge. They set forth five aspects of practical knowledge. These five aspects are consistent with the view of SCM knowledge as a tacit knowledge. First, consistent with early epistemological definitions, Von Krogh and Roos (1996) define knowledge in terms of distinction making. They note that "knowledge enables distinction making and distinctions, in turn, enable the development of new knowledge as well as the potential new distinctions they can make in the future (p. 423)." This is why, they argue, the process of distinction making is at the core of knowing.

Second, "knowing is caring." Making distinctions is one virtue of human beings, but caring about those distinctions is another. Certainly the human relationships required in the coordination and integration of specialists requires caring and the will to move forward in sharing (i.e., integrating) knowledge despite possible criticism or roadblocks. Von Krogh and Roos (1996) also suggest that caring involves making increasingly finer distinctions.

Third, "knowing is languaging." Without language, it is quite apparent that knowledge cannot "flow from one caring person to another caring person within an organization (Von Krogh and Roos 1996, p. 424)." New words and phrases may be necessary to describe new ideas and observations. Just as Eskimos have over thirty words to describe different types of snow, SCM knowledge requires a language to describe its unique knowledge, theory, and activities. Even the term "SCM" is part of the developing language of SCM knowledge. Von Krogh and Roos (1996) argue, "On the high value-added boundaries of knowledge creation, the ability to create and give meaning to new language, and rapidly diffuse it throughout the company, is a strategic advantage so far recognized by too few managers (p. 424)." Languaging may be even more important in regards to tacit knowledge than to explicit knowledge. Although tacit knowledge cannot necessarily be transmitted by language, those already sharing a common tacit knowledge often require a special language to effectively communicate within the domain of their shared tacit knowledge. The special language used by any group of skilled workers when communicating with each other would illustrate this principle.

Fourth, "knowing is shaping the future." Given that knowledge is virtually without boundaries in both time and space, there is nothing to prevent us from imaging an evolution that leads to alternative futures and even new knowledge. Albert Einstein, one of the greatest scientists of our era, would habitually conduct "mind experiments" in which he would imagine interactions and effects and explore possible alternatives. Who could argue that his imagination did not shape the future of all humankind. Von Krogh and Roos (1996) state, "because it enables you to create new distinctions, this kind of imagination activity is critical....If there [was] ever an act of strategic adaptation that mattered, it is the invention of distinctions for the future -- by caring and languaging employees (p. 425)."

Fifth, "competence is not an asset, it is an event." It is generally agreed that competencies are sources of sustainable competitive advantage (Von Krogh and Roos 1996). Therefore, any serious effort to manage knowledge or intellectual capital within a firm must address the creation and maintenance of knowledge competence. The problem is that most of the literature implies that we should view competence as an asset to be held and used as and when needed, versus an event brought about *via* the merger of a particular task with the knowledge necessary to successfully complete that task (Von Krogh and Roos 1996). The broadly held view of competence as an asset stems from the various literatures on core-competence, critical capabilities, strategic competence, etc., which suggest that competency be viewed as a tangible asset. This traditional view suggests a static management approach in which competency is developed, stocked, and utilized as and when a need arises. This corresponds to a view of knowledge competence as the building up and storing of explicit knowledge, like a student studying for an examination, in which explicit knowledge is retrieved as needed to respond to any question that may arise.

The fallacy of this approach begins with the assumption that explicit knowledge is the knowledge that leads to competence, whereas it seems more likely that tacit knowledge (i.e., skills and know-how) is the key to competence. Therefore, unlike studying for an examination, firms encounter tasks, opportunities, and challenges that require tacit knowledge (i.e., know-how and skills). Successful resolution of these tasks, opportunities, and challenges often requires the coordination of a number of specialists, within a variety of organizations.

The perspective of competence as an event requires management to view knowledge competence dynamically and suggests that organizational knowledge requires constant attention. Von Krogh and Roos (1996) note, "The challenge for management is to use the vast knowledge potential of the company to create value (p. 425)." SCM expands this argument by suggesting that management use the vast knowledge potential of the entire supply chain, not only their own organizations, to create value. To accomplish this task, Von Krogh and Roos suggest the following:

> Overall, one simple conclusion surfaces: We need a different kind of management. Thus, managing knowledge and intellectual capital is not really the issue. Rather, ... the real managerial issue is about changing our management practices to make companies sustain and flourish in the knowledge economy (1996, p. 425).

In concluding this section on organizational knowledge it seems worthwhile to re-emphasize the importance and vast potential of knowledge and its effective utilization by business organizations. The boundless nature of knowledge provides almost limitless opportunities for creating value through the appropriate application and coordination of specialist knowledge. Knowledge begets knowledge. That is, knowledge-based competencies are enhanced as they are applied (Prahalad and Hamel 1990; Glazer 1991). Finally, Senge (1997) suggests that the potential rewards of effective knowledge management are "impossible for us to overestimate (p. 32)."

SCM Knowledge

SCM knowledge is the tacit knowledge of an organization evidenced in its performance of SCM related activities. SCM is a mechanism for the coordination of specialists across a supply chain, with the objective of maximizing customer value. These definitions hinge on concepts already explored in this literature review, and summarized in Figure 7.

Concept	**Supporting Research**
Supply chain management as the coordination of supply chain activities	Houlihan 1987; Stevens 1989; Harrington 1995; Quinn 1997; Monczka & Morgan 1998; Tan, Kannan, & Handfield 1998; Handfield & Nichols 1999
Knowledge as a strategic asset	Bell 1973; Hage 1980; Nonaka & Takeuchi 1995; Slater & Narver 1995; Edvinsson & Sullivan 1996; Kuwada 1998
Knowledge and interorganizational cooperation	Achrol 1997; Handfield & Nichols 1999
Knowledge integration/coordination and specialization	Von Hippel 1988; Germain, Dröge, & Daugherty 1994; Ghingold & Johnson 1997
Customer orientation and customer value	Alderson 1957; Drucker 1973; Day & Wensley 1988; Kohli & Jaworski 1990; Webster 1992; Hunt & Morgan 1995; Slater 1997
Knowledge and customer value	Glazer 1991; Slater 1997
Practical definitions of knowledge	Machlup 1962; Goldman 1986
Organizational knowledge	Cyert & March 1963; Lawrence & Lorsch 1967; Miles & Snow 1978; Hedberg 1981; Levitt & March 1988; Huber 1991; Weick & Roberts 1993; Spender 1996a; Grant 1996b; Von Krogh & Roos 1996
Knowledge as self-reinforcing coordination mechanism	Cohen & Levinthal 1990; Prahalad & Hamel 1990; Glazer 1991; Garvin 1993; Grant 1996b
Knowledge competence and the ability to match tasks with knowledge of coordinated specialists	Von Krogh & Roos 1996; Grant 1996b; Li & Calantone 1998

Figure 7. Research Support for the Concept of SCM Knowledge

This study suggests that the relative level or degree of SCM knowledge practiced by an organization differentiates it and creates a sustainable advantage. Achrol (1991) unintentionally expresses the function of SCM knowledge in his writing,

> The next phase is at hand -- integrated knowledge of firms' worldwide markets, customers, competitors, technologies, and assets, managed to maximize its strategic flexibility and time efficiency and thus permitting rapid responses to changes in any or all of those factors (p. 80).

Alter and Hage (1993) conclude that the accumulation of knowledge continues to make manufacturing problems more and more complex, a process they refer to as "complexification". Perhaps the most acute organizational need imposed by complexification is the need for coordination mechanisms. In reality, coordination mechanisms must recognize and deal with manufacturing problems that are multifaceted and require a diverse set of skills and approaches that are available only through the coordination of a number of different specialists. These problems are often too complicated to be solved by dyadic communications (Hage 1980). Alter and Hage (1993) suggest that complex tasks require linkages (i.e., coordination of specialists) that often extend beyond a firm's boundaries into the broader supply chain. They call for "more complex kinds of coordination mechanisms (p. 123)."

SCM answers the call for a coordination mechanism to handle even the most complex tasks. For example, the design and construction of a modern business jet requires a plethora of different specializations and technologies. No single company on earth retains all of the specializations required to accomplish this task. However, using SCM practices, companies such as Bombardier Learjet can coordinate the activities of specialists in airframes, jet propulsion, avionics, hydraulics, electronics, landing gear, etc., in order to successfully design and construct a leading-edge business jet such as the new BD-100 Continental. In addition, the concurrent efforts of these various specialists reduces traditional design lead times dramatically. Using SCM processes, Bombardier Learjet and its SCM partners are able to design, test, and deliver to market an all new business jet in approximately 3 years.

Li and Calantone's (1998) recent work supports the concept of knowledge competence. Their study of "market knowledge competence" has a number of significant similarities with SCM knowledge. Li and Calantone (1998) define market knowledge competence as the processes that generate and integrate market knowledge. Similarly, SCM knowledge competence may be viewed as the processes that generate and integrate SCM knowledge.

As in this study of SCM knowledge, Li and Calantone (1998) rely on the resource-based theory of the firm (Barney 1991; Conner 1991; Day 1994b; Hunt and Morgan 1995). Exactly as proposed in this study, Li and Calantone argue that knowledge has become the scarce resource of primary importance to organizations. Specifically, they propose that market knowledge competence, organizational culture, and management skills are the tacit knowledge resources capable of generating and sustaining competitive advantage. Hunt and Morgan (1995) suggest that knowledge resources are "higher order" resources with the potential of yielding competitive advantage.

Li and Calantone (1998) develop a working definition of their concept of market knowledge competence. They also distinguish market knowledge from market knowledge competence. They define market knowledge as

> ...organized and structured information about the market. Here, organized means it is the result of systematic processing (as opposed to random picking), and structure implies that it is endowed with useful meaning (as opposed to discrete items of irrelevant data) (p. 14).

Further, they define market knowledge competence as

> ...the processes that generate and integrate market knowledge. Here, processes implies it is a series of activities (as opposed to instants of thoughts). The distinction between the two is important for empirical studies because the former is a stock, and the latter is a set of processes that generate the stock (p. 14).

Li and Calantone's (1998) definition of competence as a series of processes is supported by several studies. For example, Day's (1994b) research on market-driven organizations defines competence as "complex bundles of skills and collective learning, exercised through organizational processes (p. 38)." In their study of the core competencies of the corporation, Phahalad and Hamel (1990) identify a firm's processes of market interaction and functional integration as core organizational competencies. Using a similar approach, the operationalization (i.e., measurement) of SCM knowledge in this study relies on the ability to measure knowledge by observing the processes and activities that are associated with it.

Important similarities can be drawn between SCM knowledge and the arguments presented by Li and Calantone (1998) regarding market knowledge competence. Examples of important characteristics of both market and SCM knowledge include:

> (1) inimitableness, because processes of generating market [or SCM] knowledge are embedded in organizational cognitive activities and are not observed readily from outside (Day 1994b; Prahalad and Hamel 1990);
> (2) immobility, because these processes are created within the firm and cannot be purchased in the market (Day 1994b); and
> (3) undiminishableness, because unlike machines, whose value depreciates over time, the utility of these knowledge processes does not diminish with usage (Prahalad and Hamel 1990).

Further, Li and Calantone's (1998) operationalization of market knowledge competence is composed of three dimensions: (1) a customer knowledge dimension, (2) a competitor knowledge dimension, and (3) the marketing-research and development (R&D) interface dimension.

> A customer knowledge process refers to the set of behavioral activities that generates customer knowledge pertaining to customers' current and potential needs for new products. A competitor knowledge process involves the set of behavioral activities that generates knowledge about competitors' products and strategies. The marketing-R&D interface refers to the process in which marketing and R&D functions communicate and cooperate with each other (p.14).

It is particularly interesting to note how Li and Calantone's operationalization pushes knowledge competence beyond the boundaries of the firm to include knowledge of customers and competitors.

In a like manner, the operationalization of SCM knowledge is composed of a number of measurable activities. As with market knowledge competence, SCM knowledge is divided into three dimensions: (1) upstream SCM knowledge, (2) internal SCM knowledge, and (3) downstream SCM knowledge. As with market knowledge competence, SCM knowledge is measured *via* its related activities. Upstream SCM activities are representative of SCM knowledge competence related to the manufacturer/supplier interface; internal SCM activities are representative of SCM knowledge competence related to internal processes; and downstream SCM activities are representative of SCM knowledge competence related to the manufacturer/customer interface.

Comments on SCM Knowledge

Before concluding this review of SCM knowledge, a few additional supporting ideas deserve some brief mention. Among these, Rumelt, Schendel, and Teece's (1991) observation that "organizational capabilities, rather than product-market positions or tactics, [are] the enduring source of competitive advantage (p. 22)." Effective SCM is just such an organizational capability.

SCM knowledge is a strategic capability that can create and sustain competitive advantage. The potential benefit to firms that effectively obtain and increase their SCM knowledge is great. Finally, Plato provides an interesting anecdote that may be applicable to organizations that continue to operate without an understanding of SCM knowledge and the forces that create and sustain their competitive advantage. "You have noticed that opinions without knowledge are all ugly. The best of them are blind. Don't you think that those who, without intelligence, have a true opinion are like blind men going along on the right road? (Rouse 1984, p. 305)" Such "blindness on the right road" provides only temporary success in today's rapidly changing business environment.

Organizational Structure

The same forces that nurture the evolution of SCM knowledge are major causes of concern to management. These forces include the increasing diversity and change in environmental conditions (e.g., technology and global competition). In addition, the pace of change continues to increase, bringing even more urgency to these issues. Both process and product technologies are becoming evermore complex as corporations simultaneously experience global expansion and more diverse economic and cultural conditions. Lawrence and Lorsch (1967, forward) note,

> The pace of technological and market changes is so rapid, our need to know what forms of organizational arrangements will cope most effectively with change imposed from outside and which of these forms will facilitate those internal changes so necessary to continuing economic progress is essential.

The relevance of this statement is even more startling when we consider that it was made before the advent of the Internet and wide-spread computerization.

As forecast by Hage (1980), these trends have not only continued they have accelerated. Lawrence and Lorsch (1967) argue that as systems grow, they differentiate into specialist parts or subunits. The effective functioning of the organization thus depends on the effective coordination and integration of these specialist parts. Lawrence and Lorsch (1967) use the analogy of a human body to illustrate this point; the various specialized organs and tissues all integrated and coordinated by and through the nervous system and the brain. Specialization or differentiation is "a result of the fact that any one group of managers has a limited span of surveillance. Each one has the capacity to deal with only a portion of the total environment (Lawrence and Lorsch 1967, p. 8)." Integration and coordination are required to link together the differentiated subparts (i.e., specialists) in order to accomplish the organization's purposes and objectives without suffering massive suboptimization within subunits.

The following sections discuss the development of organizations, organizational theory, organizational structure, and the various elements that define organizational structure.

The Development of Organizations and Organizational Theory

An understanding of modern organizational structures requires a review of the history and development of organizational forms. Through the early Industrial Revolution of the late 1800's the owner-manager organizational structure, with its strict centralization and control, was the dominant organizational structure. Following the Industrial Revolution, the vertically integrated functionally organized structure appeared (Chandler 1962, 1977). This organizational type was effective in its day, at providing high-volume, standardized, low-cost products. The prevailing environment of the period was one of relative stability and "markets were characterized by low purchasing power and simple preferences (Achrol 1997, p. 57)."

Early organizational researchers include Weber (1946), who views structure from the perspective of how work is organized. For example, he proposes that structure determines the amount and quality of product produced or service provided. Further, Weber suggests that efficiency is best achieved through a strict hierarchy of authority and a reliance on rules. Supported by laboratory experiments, Weber's endorsement of strict hierarchies to achieve optimal performance became the established paradigm that formed the foundation of most subsequent research.

Driven by the huge production demands of WWI, the multidivisional organization form emerged, General Motors being a typical example. The added flexibility and growth potential of the multidivisional form allowed organizations to be, "more market and product oriented and was much better suited to an affluent market characterized by a variety of tastes and preferences (Achrol 1997, p. 57). By the 1960s and 70s, with market preferences and product technologies becoming increasingly more complex, the multidivisional form began to show weakness in its inability to coordinate specialist knowledge either within or across organizations.

These developments in the business world led to the first serious deviations from Weber's work, among which was the development of the theory of mechanical versus organic organizational forms developed by Burns and Stalker (1961), followed closely by Hage's (1965) axiomatic theory. Both research streams attempt to build upon Weber's earlier work. In recognition of Weber's work, it is worth noting that the organic models developed by Burns and Stalker (1961) and Hage (1965) could not have existed at the time of Weber's writing, given the evolution of industry (Hage 1980).

Hage (1965) sought to explain organic organizational forms that began to develop at the end of WWII. Figure 8, adapted from Hage (1980, p.125-130), summarizes the basic differences between mechanical and organic structures.

Mechanical	**Organic**
Hierarchical structure of control, authority, and communication	Network structure of control, authority, and communication
A tendency for operations and working behavior to be governed by instructions and decisions issued by superiors	A context of communication that consists of information and advice
The specialized differentiation of functional tasks	The adjustment and continual redefinition of task
Greater importance attached to local rather than cosmopolitan knowledge	Greater importance attached to affiliations and expertise valid to the goal but external to it
The precise definition of rights, obligations, and technical methods attached to a role	The realistic nature of the task which is seen as set by the total situation of the concern
A tendency for interaction to be vertical	A lateral rather than a vertical direction of communication
Loyalty to superiors	Loyalty to technological processes

Figure 8. Mechanical and Organic Organization Structures

Hage (1965, 1980), along with other researchers, suggests that organic organizational structures perform better in unstable environments, whereas mechanical organizational structures work better is stable environments. Finding out why this was so became the focus of his research. Hage (1980) explains the importance of this distinction as follows:

> Stable conditions permit the separation of work into separate tasks or offices, to use Weber's term. Following an argument of March and Simon (1958: 158-160), who influenced Burns and Stalker, organizations develop programs of action where the rules are precisely specified. Under these conditions, the bureaucratic mechanisms involved in Weber's model operate with efficiency. It is easier to supervise and to enforce compliance. With a specific program or action, interaction need only follow the chain of command. That is, it is vertical, and moves largely upward with reports and questions. Downward communication need involve only orders and instructions. In other words, the desire or strain is always towards the bureaucratic form, but if conditions are changing all the time, then this form is not *via*ble. The changing circumstances make programs impossible, including, in the extreme, a clear chain of command. Beyond this, there is the implied assumption of team solutions to unique problems, which necessitate lateral interaction in a network of control and an emphasis on consultation and advice. Since there are different abilities, the center of control keeps shifting, depending on the nature of the problem and whose expertise is the greatest. Presumably, team solutions are better because of the difficulty of finding the novel solution to a difficult problem (p. 32).

Further, Hage (1980) emphasizes that the creativity required to support continuous new product development requires a structure or mechanism that can integrate relevant specialists from throughout the organization. Solutions to complex problems including new product development are often a collective product resulting from the interaction of specialist knowledge. The integration and coordination of knowledge thus "...mitigates against hierarchies, rules, supervision, and other characteristics of the mechanical model (Hage 1980, p. 35)."

Hage (1980) argues for an ultimate evolutionary bias towards the organic form because of the steady increase in knowledge as expressed by continuous increases in market and technological complexity. The organic form seemed destined to become the organization of the post-industrial society (Bell 1973). From a sociological perspective, Simon (1957) portrays the organic organization as a more open administrative process in which workers are less machine-like and more human in their rationality and in pursuing their own interests. Blau (1956) surmises that it is irrational to view an organization as rational because doing so does not take into account the non-rational behavior of people. Such a perspective summarizes the natural or organismic metaphor wherein organizations are seen as complex living entities rather than machines.

Attempts to look beyond the organic paradigm include Hage (1980), who pondered the creation of various hybrids and new organizational forms that could overcome the paradox created by organic forms. The new forms of organizations he envisioned include the mixed breed (part organic and part mechanic), and the matrix form of organization with its emphasis on lateral relationships and multiple lines of responsibility and authority. As exemplified by firms such as TRW and Matsushita, matrix organizations are often able to achieve closer alignment of their functions to minimize suboptimization while optimizing total firm performance.

Lawrence and Lorsch (1967) focus much of their work on the classical foundations of differentiation (i.e., how best to divide tasks) and integration. They suggest that earlier researchers failed to recognize the systemic nature of organizations. Further, they presume that continued growth and differentiation through departmentalization will serve the organization. The work of Lawrence and Lorsch

(1967) helps explain the growth and prominence of the multi-divisional departmentalized organization of the 20th century. Unfortunately, such organizations seem ill-suited to the challenges of the 21st century.

Another important perspective championed by Lawrence and Lorsch (1967) is based on the long-term effects of specialization *via* departmental segmentation. Lawrence and Lorsch (1967) argue that, over time, specialization influences the behavior and attitudes of organizational specialists and ultimately changes the types of coordination mechanisms required to integrate the increasingly complex variety of specialists needed to accomplish a firm's purposes. Because specialists, organized in departments, develop different interests and viewpoints over time, Lawrence and Lorsch (1967) suggest they will find it more and more difficult to reach agreement (i.e., integrate) on common purposes and objectives.

> This very elementary example of a built-in conflict of interest is compounded a hundred times over in a real organization, and the issues at stake are seldom so clear cut. It does, however, illustrate how we define integration - the quality of the state of collaboration that exists among departments that are required to achieve unity of effort by the demands of the environment (Lawrence and Lorsch 1967, p. 11).

In today's organizations, this problem is vastly amplified by the necessity to collaborate and integrate not only within the firm, but also throughout the supply chain. Consideration of the many diverse technologies and specialists that must be coordinated in order to design and manufacture a modern automobile serves to illustrate this point.

In the 1980s a new organizational form, the network organization, began to appear (Powell 1990). Based on the example of Japanese global enterprise "...it became increasingly apparent that many of their success factors were external to the firm -- that is, transorganizational in nature (Achrol 1997, p. 57)." The network organization is designed to thrive in environments of rapid and increasing technological change "...fueled by an explosion in the growth and availability of knowledge (Achrol 1997, p. 57)." This explosion of knowledge creates a tremendous driving force encouraging firms towards interorganizational cooperation.

The conventional organizational approach of buffering against external uncertainty *via* vertical integration (Pfeffer and Salancik 1978; Thompson 1967; Williamson 1975) leads to suboptimization in dynamic environments (Achrol 1997). Also, in dynamic environments, organizational efficiency is defined in terms of a firm's speed and agility in processing information. Achrol (1997) confirms this perspective in his statement:

> Hence any advantages of vertical control are eroded by the costs of attendant inflexibility and inertia. Not only do hierarchy and buffering mechanisms create unacceptable levels of organizational inertia for turbulent environments, but they are likely to prove hopelessly inadequate in the knowledge-rich environments of the future (p. 58).

Knowledge is replacing capital and energy as the primary wealth-creating asset (Bell 1973). Organizations deal with more and more knowledge by increasing the type and number of specialists. This task specialization and the creation of subunits serves to buffer the organization from information overload (Huber 1984). The challenge that increased specialization presents to organizations is one of coordination.

Drucker (1988), who envisions a future in which businesses operate like hospitals, universities, or symphony orchestras expresses one vision of coordination utopia. Like them, he suggests, the typical business will be knowledge based, composed largely of specialists who direct and discipline their own performance, and organized *via* feedback from colleagues, customers, and headquarters. Achrol's (1997) work on network organizations suggests that interorganizational specialist knowledge is required to successfully manage many of today's and tomorrow's complex business problems. However, Achrol does not specifically address the strategic mechanisms necessary to coordinate that specialist knowledge. This study specifically addresses the issue of coordination by proposing that SCM knowledge provides the needed mechanism for internal and supply chain coordination.

In conclusion, it has been shown that the attributes of SCM knowledge are consistent with, and complementary to, the advanced evolutionary organizational structures suggested by Achrol (1997), Drucker (1988), Hage (1980), Miles and Snow (1992), and Slater and Narver (1995).

Predictors of Organization Structure

Miles and Snow (1978) state, "Management's strategic choices shape the organization's structure and process (p. 7)." In their research on organizational structure, Miles and Snow (1978) seek to develop a model that takes into account the interrelationships between strategy, structure, and process. They argue that an organization's strategy can be inferred from its behavior. The concept that strategy is associated with intent, and structure with action (Mintzberg 1979) provides evidence of a link between strategy and structure (e.g., Chandler 1962; Drucker 1954, 1974).

In his study of 100 U.S. companies, Chandler (1962) discovers that "...a new strategy required a new or at least refashioned structure if the enlarged enterprise was to be operated efficiently (p. 15)." However, it is also clear from both Chandler's and Drucker's work that the any causal linkage between strategy and structure is complex.

On one hand, the research of Drucker (1954, 1974), Chandler (1962) and Perrow (1967, 1970) suggests that structure follows strategy and that organizational effectiveness is based on the proper alignment of the two. On the other hand, the work of Cyert and March (1963), Fouraker and Stopford (1968), and March and Simon (1958) suggests that structure constrains strategy in that it may be difficult for an organization to change its course once it has adopted a particular strategy-structure arrangement. In an attempt to reconcile these apparently conflicting conclusions, Miles and Snow describe four types of organizations representing alternative strategy-structure combinations that organizations use to adapt to their environment. Miles and Snow label these four organizational types: defenders, analyzers, prospectors, and reactors.

Other early organizational studies include Woodward (1958), who reports that successful organizations have different organizational structures based on their production technology. For example, she found that within industries characterized by job-shop production technology the most successful firms had relatively wide spans of supervisory control and fewer hierarchical levels than did successful firms in industries with continuous-process technology.

Burns and Stalker (1961) report a similar finding in their comparative study of firms in dynamic versus stable industries. Organizations in stable industries tended to be more mechanistic with greater reliance on formal rules and procedures. Decisions were reached at higher levels of the organization and there were narrower spans of supervisory control. On the other hand, effective organizations in the more dynamic industries were typically more organic. There was less attention to formal procedures and spans of supervisory control were wider. Decisions were more likely to be reached at the middle level of the organization. Together, these studies suggest that differing technical and economic conditions outside the firm necessitate different organizational structures within it.

SCM knowledge, as previously discussed, is thought to be driven by rapid change and increasing complexity (Handfield and Nichols 1999). Therefore, organizational structures that are thought to exist and thrive in environments characterized by rapid change and complexity are of particular interest to this study. Hickson, Pugh, and Pheysey (1969), looking for matches between different environments and organizational types, focus on two distinct organizational types: organic and mechanistic structures. Support for this approach came from Burns and Stalker (1961), who suggest that organic structures are more suitable in environments characterized by high rates of technical and market change, whereas mechanical structures are more suited to low rates of technical and market change.

In exploring potential predictors of organizational structure, a number of early researchers focus on the role of production or process technology and its effects on organizational structure. To facilitate this line of research, multiple measures of technology were developed (e.g., operations technology and materials technology). Pugh et al. (1963), for example, defines a firm's operations technology as "...the techniques that it uses in its workflow activities (p. 310)." The concept is also defined as the equipping and sequencing of activities in the workflow. Perrow (1967) broadens the definition of technology by describing materials technology as "...the actions that an individual performs upon an object...in order to make some change in that object (p. 195)."

An investigation by Perrow (1967) of the relationship between organizational structure and workflow integration (i.e., the number of exceptional cases encountered in the work) concludes that operations technology (workflow integration) accounts for but a small proportion of the total variance in structural features. Hickson, Pugh, and Pheysey (1969) also conclude that the broad "technological imperative" hypothesis (i.e., that operations technology is of primary importance to structure) is not supported.

Later explorations of organizational structure and its relationship to other variables includes the work of Schotter (1981), who proposes that "Every evolutionary economic problem requires a social institution to solve it (p. 2)." Just so, the economic problem of accelerated market and technological complexity requires a strategy or institution to solve it. Glazer (1991) also notes the apparent co-evolution of problem and solution. He states, "...the notion that firm strategy and structure evolve together is a central theme of most organizational theorists (p. 14)".

Glazer (1991) develops a number of propositions related to organizational structure and the "information intensity"' of a firm. He proposes that the more information intensive a firm, the (1) shorter its products' life cycles; (2) the greater the degree of involvement in strategic alliances; (3) the greater the customer participation in product creation and design; and (4) the greater the reliance on decision groups or teams and the parallel rather than sequential processing of information. Glazer's (1991) work provides strong support for many of the relationships hypothesized in this study.

Claycomb, Germain, and Dröge (1999) describe the structure of an organization as the framework for how the organization "...divides its work into distinct tasks and then achieves coordination among these tasks (p. 6)". A number of other marketing studies also support the argument that strategies lead to structural changes (e.g., Germain, Dröge, and Daugherty 1994; Larson 1994). This study does not seek to identify specific causal linkage between SCM knowledge and organizational structure, but rather proposes a positive relationship between SCM knowledge and organizational structure.

The relevance of this study is further supported by the work of Selto, Renner, and Young (1995) who emphasize the lack of attention paid to the relationship between knowledge and organizational structure. While it may be generally accepted that the effective implementation of certain types of knowledge (e.g., JIT) is related to organizational structure (e.g., Dean and Snell 1991; Germain, Dröge, and Daugherty 1994), "there is a paucity of empirical research relating ... strategy to specific dimensions of organizational structure (Claycomb, Germain, Dröge 1999, p. 6)." This study seeks to fill this void by providing an empirical investigation of the relationships between SCM knowledge and specific dimensions of organizational structure.

The Paradox of Organic Structures

An important focus of early organizational research is the distinction between organic and mechanistic organizational structures. The industrial revolution produced firms that were generally inclined towards mechanistic structures, and the beginning of the post-industrial age triggered an interest in the potential benefits of new (e.g., organic) structures. Organic structures are generally more open to learning, innovation, participative decision making, and flexibility than are mechanistic structures (Hurley and Hult 1998; Nonaka and Takeuchi 1995; Pierce and Delbecq 1977; Shepard 1967).

So important to Hage (1980) is the distinction between mechanical and organic forms that he claims "The first and most fundamental transformation process is the movement along the diagonal of mechanical versus organic (p. 266)." Although research generally supports the proposition that the characteristics of organic structures enhance innovation (Pierce and Delbecq 1977; Zaltman, Duncan, and Holbeck 1973), the same research also concludes that these same characteristics often hinder adoption of new products and processes. Adoption, it was found, requires some formalization and centralization of decision making to decrease conflict (Pierce and Delbecq 1977).

A paradox thus emerges. Although organic structures seem to provide a superior structure for the communication and sharing of knowledge, they simultaneously fail to provide an effective structure for the coordination or integration of that knowledge. Herein lies a critical internal contradiction in Weber's (1946) bureaucratic model. That is, an organization cannot continue to be effective without the combination of innovation, production, efficiency, and morale (Parsons 1966; Price 1968). However, early research reveals no known organizational structure capable of simultaneously maximizing innovation, production, efficiency, and morale. Regarding this paradox, Hage (1980) states,

> Perhaps the most interesting implication of the causal structure combined with the limits proposition is that while there is a long-term trend towards more complexity and greater decentralization, there are many counter-cyclical movements towards greater centralization because of the dilemmas inherent between the two production blocks (p. 45).

Attempting to resolve this paradox, Graham and Pizzo (1996) suggest the need for balance between a fluid (organic) organization structure and an institutional (mechanical) structure in order to maximize total system performance. They introduce the concept of

JED (just-enough-discipline) as a means for maintaining this balance. Other attempts at resolving the paradox between organic and mechanical structures include establishing separate organizations for development and for implementation of new products and ideas. This study proposes that SCM knowledge, with its focus on customer value, is capable of solving the paradox by maximizing overall system performance.

Elements of Organization Structure

All organizations have structure -- it is the anatomy of an organization. Structure is the framework within which the organization functions (Dalton et al. 1980). Just as all parts of a biological anatomy affect and are affected by the body, so the members of an organization affect and are affected by the organizational structure. As Dalton et al. (1980) explain,

> This belief is based on a simple observation. Buildings have halls, stairways, entries, exits, walls, and roofs. The specific structure of a building is a major determinant of the activities of the people within it. Similarly, behavior in organizations is influenced by the organization's structure. The influence of this structure, while not as apparent as that of a building, is assumed to be pervasive (p. 49).

Hall (1977) suggests that structure has two basic functions: "First, structures are designed to minimize or at least regulate the influence of individual variations on the organization," and second, "structure is the setting in which power is exercised..., decisions are made..., and...the organization's activities are carried out (p. 109)." Organizational structure is important to the performance (i.e., efficiency, moral, and effectiveness) of organizations (Van de Ven 1976).

As previously discussed, tacit knowledge (e.g., SCM knowledge) is revealed through a firm's activities. Given that organizational structure is the setting in which activities are carried out, and that SCM knowledge is expressed through a firm's activities, then we can deduce that a relationship must exist between SCM knowledge and organizational structure.

The purpose of this study is to empirically test a model of the relationship between SCM knowledge and organizational structure. Before proceeding further in this study, a review of the literature regarding elements of organizational structure is in order. There is a rich history of empirical research identifying and incorporating various elements of organizational structure. The Aston researchers (Pugh et al. 1968, 1969) were among the first to isolate the central dimensions of structure based on their studies of British firms. They document four distinct dimensions of structure: (1) structuring of activities (i.e., specialization and formalization), (2) concentration of authority (i.e., centralization of decision-making power), (3) line control of workflow (i.e., use of many line supervisors rather than impersonal formal controls of task performance), and (4) size of the supportive (nonline) component.

Subsequent work done by Child (1972) produces similar results, except that he included concentration of authority in the same factor as structuring of activities. Reimann (1973) documents three related dimensions of structure: centralization of authority, specialization, and formalization. Miller and Dröge (1986), in a review of recent literature (e.g., Champion 1975; Fredrickson 1984; Hall 1977; Jackson and Morgan 1982; Van de Ven 1976) note, "...the composite dimensions of formalization, complexity, and centralization emerged most consistently in studies of the components of organization structure (p. 543)." Overall, studies of organizational structure have consistently included the elements of centralization, formalization (e.g., performance control), and specialization (Champion 1975; Miller 1991; Mintzberg 1979; Pugh et al. 1968).

Driven by environmental demands being placed on organizations to coordinate and integrate disparate knowledge from throughout the system, early organizational literature began to focus on the concepts of specialization, centralization, and formalization (Pugh et al. 1963). Taking a slightly different approach, Hage's (1965) axiomatic theory uses key concepts from Weber's model of bureaucracy and develops similar concepts. Specifically, Hage translated Weber's concept of hierarchy of authority into centralization, as defined by the hierarchical level at which decisions are made. Similarly, Weber's concept of emphasizing rules was translated by Hage as the degree of formalization. Finally, from Weber's model Hage identified specialization as an important element of organizational structure.

In support of Hage's (1965) work, Miller, Glick, and Huber (1991) confirm that centralization, formalization, and specialization are three of the most important and popular organizational structure variables. These three basic structural elements are well-established in the management literature (e.g., Fry 1982; Hage 1980; Pugh et al. 1968; Weber 1946).

More recently, and coincidental with the popularity of organizational knowledge research, a fourth dimension of structure has been added -- that of integration (Achrol 1991; Germain, Dröge, and Daugherty 1994; Olson, Walker, and Ruekert 1995; Workman 1993). As previously mentioned, integration is critical to an organization's ability to effectively coordinate specialist knowledge. Historically, integration has been viewed merely as the passive use of liaison devices such as task forces, committees, and integrative personnel (Galbraith 1973; Lawrence and Lorsch 1967; Miller and Friesen 1984; Mintzberg 1979). However, as organizational knowledge has increased and organizations have become more complex and differentiated, the urgency of employing effective integrative devices has become apparent (Galbraith 1973; Lawrence and Lorsch 1967).

In order to ensure the completeness of this study, all four of these key structural elements: centralization, performance control (i.e., formalization), specialization, and integration are included in this study. With this basic understanding of the elements of organizational structure, we can now proceed with the hypotheses.

SCM Knowledge and Organization Structure: The Hypotheses

Hypothesis 1: Decentralization

Child and Mansfield (1972) define centralization as "the average locus of decision-making over a list of repeated decisions along a hierarchical scale running from operative level up to decisions taken above the chief executive (p. 370)." The concept of centralization evolves from Weber's (1946) early work in organizational structure in which he described hierarchies in terms of how many decisions are made at the various levels. Hage (1965), in developing his axiomatic theory of organizations, takes Weber's (1946) model of bureaucracy and translates the concept of hierarchy of authority as the degree of centralization.

Hage (1980) logically concludes that as organizations seek to adapt to environments characterized by greater and greater knowledge and complexity, the knowledge required to make an increasing number of organizational decisions resides, to an increasingly greater degree, within specialists. These specialists, who are increasingly expected to make decisions, are located at mid and lower levels of the organizational hierarchies. The conclusion of this logic is that increasing knowledge and complexity leads organizations to a greater decentralization of decision-making authority. Hage (1980) summarizes his study of centralization with several formal propositions: (1) the more complexity, the less centralization, and vice-versa, and (2) the more centralization, the less innovation and vice versa.

Despite the suggestion of an irreversible trend towards decentralization, based on the continuous growth in knowledge and complexity, Hage (1980) also notes there are counter cyclical movements pushing organizations towards greater centralization because of the dilemmas inherent between organic and mechanistic organizational structures. Because some question remains regarding the relationship between knowledge and centralization, the results of this study provide important and meaningful information.

Based on the research just described, this study proposes that increased SCM knowledge predicts greater decentralization of decision-making authority. In further support of this proposition, several recent studies suggest that JIT partners may be more decentralized (e.g., Davy et al. 1992; Giunipero and Law 1990; Ruekert, Walker, and Roering 1985). Decentralization reduces both top management control costs and decision-making burdens and provides managers closer to relevant information the latitude to act (Child 1973; Moch 1976).

It is, therefore, hypothesized that SCM knowledge is positively related to organizational decentralization. As previously explained, SCM knowledge is divided into three dimensions: upstream SCM knowledge (the level of SCM knowledge exhibited with suppliers), internal SCM knowledge (the level of SCM knowledge exhibited within the organization), and downstream SCM knowledge (the level of SCM knowledge exhibited with customers). This division of SCM knowledge dimensions is consistent with the marketing literature (Li and Calantone 1998). Justifying the measurement of interorganizaitonal activities (i.e., upstream and downstream SCM knowledge) by polling the perceptions of a single respondent, Achrol, Reve, and Stern (1983) recommend that "In order to study networks of organizational interactions ... first one needs to understand the basic transactions or acts of exchange between pairs of social actors by applying a dyadic interaction model (p. 56)." Aldrich and Whetten (1981) further acknowledge, "The starting point for all studies of aggregates of organizations is a relation or transaction between two organizations (p.385)." Specifically then, the hypotheses related to SCM knowledge and decentralization are:

H1a: Upstream SCM knowledge and decentralization are positively related.

H1b: Internal SCM knowledge and decentralization are positively related.

H1c: Downstream SCM knowledge and decentralization are positively related.

Hypothesis 2: Performance Control

The early work of Aiken and Hage (1966) suggests that formalization be "...measured by the proportion of codified jobs and the range of variation that is tolerated with the rules defining the jobs. The higher the proportion of codified jobs and the less the range of variation allowed, the more formalized the organization (p. 499)." The evolution of formalization as an element of organizational structure has, over time, altered dramatically original measures of formalization. For example, Khandwalla (1974) suggests the formal recording and reporting of various performance measures provides a valid measurement of formalization. This study incorporates Khandwalla's perspective of formalization as performance control. Handfield and Nichols (1999), in their recent study of SCM, consider formalized performance measurement to be key to effective SCM. Performance control has also been referred to as "after-the-fact monitoring of results (Mintzberg 1979, p. 149)."

In addition to Handfield and Nichols' (1999) confirmation of the importance of performance control in relation to SCM processes and practices, other marketing researchers also emphasize the importance of performance appraisal systems (e.g., Carter and Narasimhan 1994; Jaworski, Stathakopoulos, and Krishnan 1993). Because of the close relationship between JIT and SCM, studies relating performance control with JIT systems are particularly germane to this study (e.g., Frazier, Spekman, and O'Neal 1988).

JIT researchers propose that JIT practices predict performance control for several reasons. The first reason relates to the knowledge aspects of JIT. Specifically, the reduced inventory levels sought by JIT practitioners (e.g., Chapman and Carter 1990; O'Neal 1987) requires an accompanying increase in the flow of, and access to, relevant knowledge and information (e.g., Daniel and Reitsperger 1991; Yoo 1989) including performance measures (Handfield and Nichols 1999).

Second, "...intensive management of processes demands intensive measurement, especially as exactness and process cost management become critical (Germain, Dröge, and Daugherty 1994, p. 473)." As Hage (1980) suggests concerning knowledge-rich societies, buyers are demanding higher quality, more customized products, better value, and more innovation. These demands force manufacturers to meticulously monitor and control their processes which requires the use of performance measures.

Third, the relationships, shared objectives, and trust that are necessarily part of effective JIT and/or SCM practices require the sharing of performance data across supply chain partners. Indeed, without the monitoring and sharing of performance data across the supply chain, it would not be possible to optimize the system. Germain, Dröge, and Daugherty (1994) suggest that the sharing of performance information strengthens the relationships between supply chain partners. In support of this view, JIT researchers have found that JIT partners are more likely than other buyer-supplier dyads to share cost information (Freeland 1991). In summary, relational exchange is characterized by "significant attention to measuring, specifying and quantifying all aspects of performance (Dwyer, Schurr, and Oh 1987, p. 13)."

Based on these arguments, it is hypothesized that SCM knowledge and organizational performance control are positively related. Specifically, it is hypothesized that:

H2a: Upstream SCM knowledge and performance control are positively related.

H2b: Internal SCM knowledge and performance control are positively related.

H2c: Downstream SCM knowledge and performance control are positively related.

Hypothesis 3: Specialization

Specialization is defined as the extent to which jobs in an organization require narrowly defined skills or expertise (Mintzberg 1979). This is not to be confused with job specialization related to the breadth of tasks performed by a worker, as is often the definition in the popular business literature. SCM knowledge is generally thought to result in increased specialization. Again, relying on the similarity between SCM and JIT, this study refers to various JIT related research in support of the proposed relationship between SCM knowledge and specialization. For example, O'Neal (1987), based on a survey of buyers, forecast the emergence of a number of new specialists to support interorganizational JIT activities. Germain, Dröge, and Daugherty (1994), commenting on the increase of specialists related to JIT exchanges, note,

> The sharing of production schedules or demand forecasts, the additional value-added activities performed by JIT sellers, the complexity associated with distributing many small-lot shipments of variable size, and the possible need to adopt new technologies should all escalate the skill level required due to JIT selling (p. 473).

Frazier, Spekman, and O'Neal (1988) also suggest that "JIT exchanges involve at least moderate levels of specialized investments in human assets (p. 55)."

At the individual level there is a limit to cognition and memory (March and Simon 1958). Therefore, as knowledge expands it is broken into pieces, normally along the lines of established disciplines mastered by specialists (Dewar and Hage 1978). In the larger sociological literature, this process is referred to as structural differentiation (Parsons 1966). In regards to specialization, teams of specialists can handle complex tasks impossible for individuals to handle. Just so, new knowledge unabsorbable by current specialists requires the creation and development of new specialties and the education and training of new specialists. Based on this reasoning, Hage (1980) suggests that as knowledge and technology increase more and more specialists are needed to contain the knowledge.

Although classic organizational research suggests that organization size drives specialization or differentiation (e.g., Durkheim 1933), this study subscribes to the more recent assertion that the growth of knowledge also drives specialization (Hage 1980). Hage (1980) affirms, "The main issue is that as task scope [i.e., knowledge] increases, the organization form is shifted from a mechanical to an organic form (p. 390)." Based on the evidence, we conclude that the long-term trend in the growth of knowledge has major implications for how organizations are structured, including an increase in specialization.

It is most important that specialization, as used in this study, is understood properly. It is not the task specialization of assembly line workers that is often thought of. Hage (1980) provides a clear differentiation between the knowledge-based task specialization referred to in this study, and the task specialization often referred to in industry. He states that we must "...make a distinction between task specialization and person specialization. Task specialization occurs along the assembly line and is not the same as the development of new professional or managerial specialties (p.388)." He further notes, "The growth in new specialties.... [is] the single most important aspect of structural differentiation relative to the organization, and yet this has not been studied. Machines and tools have received more attention than expertise and skills (p. 388)." This study seeks to contribute to the literature by providing empirically-based insight into this important element of organizational structure.

Achrol (1991), commenting on the importance of specialization to organizational structure, notes that the increase is specialization is "...no less significant than the industrial revolution in the nineteenth century or the green revolution in agriculture of the 1960's (p. 78)." Miles and Snow (1984) believe that organizations of the future will be more vertically disaggregated and rely heavily upon networks or teams of specialists. Hage (1980) predicts, "the greater the task scope, the greater the concentration of specialists (p. 389)."

It is, therefore, hypothesized that as SCM knowledge and specialization are positively related. Specifically, it is hypothesized that:

H3a: Upstream SCM knowledge and specialization are positively related.

H3b: Internal SCM knowledge and specialization are positively related.

H3c: Downstream SCM knowledge and specialization are positively related.

Hypothesis 4: Integration

Integration refers to "lateral links that coordinate differentiated subunits, reduce conflict and duplication, foster mutual adjustment, and coalesce subunits toward meeting overall organizational objectives (Germain, Dröge, and Daugherty 1994, p. 472)." Integration has been associated with knowledge-based practices including JIT (Frazier, Speckman, and O'Neal 1988; Giunipero and Law 1990; Natarajan and Weinrauch 1990) and supply chain management (Houlihan 1987; Slater 1997). The purpose of integration is to avoid suboptimization and promote synergistic relationships and handoffs throughout the value chain.

Integration is accomplished *via* the coordination of specialists (Hage 1980). Coordination is the key to managing the growth of knowledge (Hage 1980). The importance of coordination to SCM knowledge is evidenced in the definition applied to SCM knowledge in this study. That is, SCM knowledge is a mechanism for the coordination of specialist knowledge across the supply chain.

Empirical evidence of a relationship between SCM knowledge and integration does not currently exist in the marketing literature. However, some support is found in related literatures. For example, Gustin, Daugherty, and Stank. (1995) find support for a relationship between information availability and integration. Other research finds evidence of a relationship between group cognition and integration (e.g., Madhavan and Rajiv 1998; Patel et al. 1996).

Germain, Dröge, and Daugherty (1994), in their study of JIT, hypothesize but fail to find a significant relationship between JIT and integration. Despite this setback, the bulk of the literature and the arguments contained in this study all suggest a relationship between SCM knowledge and integration. The lack of evidence found in Germain et al.'s (1994) study only makes the empirical findings of this study even more important in helping to solidify the theoretical relationship between SCM knowledge and integration.

It is hypothesized that increased SCM knowledge and integration are positively related. Specifically, it is hypothesized that;

H4a: Upstream SCM knowledge and integration are positively related.

H4b: Internal SCM knowledge and integration are positively related.

H4c: Downstream SCM knowledge and integration are positively related.

Context Variables

Before proceeding to describe the research methodology, it is important that we recognize and discuss the influence of other variables that may either directly affect organizational structure or moderate the hypothesized relationships between the dimensions of SCM knowledge and the elements of organizational structure. These other variables include organization size, product complexity, and environmental uncertainty. Miller and Dröge (1986) emphasize the importance of considering these variables, as well as the controversy over the relative impact of each (Kimberly 1976; Singh 1985). Here, we provide a brief overview of each variable as it relates to this study.

Historical Perspective

Early research into the predictors of organizational form focused principally on two major contexts: size and technology. In fact, the intellectual pursuit of these two concepts (size and technology) and their interrelationship spawned a substantial literature. From the earliest studies, the number of employees of an organization has been the most commonly used measure of organizational size. The advantages of this measure are that it is simple, inexpensive, and strongly correlated with budget. Another important context variable, technology, has proved to be much more difficult to measure (Perrow 1970; Woodward 1965) or even to conceptualize (Hickson, Pugh, and Pheysey 1969; Van de Ven 1976). According to Hage (1980), "Both size and technology have been associated with various theories that represent, in certain aspects, the main intellectual achievements in the study of organizations during the past decade (p. 380)." Despite the research activity in these areas, the old question, "What determines organizational form?" still begs to be answered (Hage 1980). This study hopes to contribute to that answer.

Hage (1980) suggests that technology has a greater affect on the concentration of specialists, whereas personnel size has a greater affect on centralization (Freeman 1973). In some of the earliest work related to technology and organizational structure, Woodward (1965) shows, based on data obtained from 1950's English industrial firms, a strong correlation between process technology (i.e., batch, assembly line, mass production, and continuous process) and organizational structure. A year later, and independent of Woodward's study, Blauner (1964) discovers a similar correlation in American industry.

Based partially on these early studies, Perrow (1967) suggests that the contextual variable ‘technology’ be viewed as the relative routineness of technology. Other research by Lefton and Rosengran (1966) develops the concept of latitude and longitude of client treatment, as a major antecedent of structure. Building on the work of these early researchers, Hage (1980) develops a measure of technology called 'task scope'. Hage believed that the principle advantage of the term ‘task scope’ is that it calls more attention to the problem of how much knowledge (versus equipment) is needed to complete the task.

Previous to Hage’s definition of task scope, technology was generally considered to include both machines and knowledge (Hickson, Pugh, and Pheysey 1969), but Hage believed the knowledge component had not been sufficiently explored. Thus, Hage (1980) defines task scope as, "the amount and variety of knowledge employed by the organization in its production of goods or provision of services (p. 385)." Hage's (1980) operationalization of technology as task scope uses concentration of specialists as the measure of task scope (vs. specialization as measured by the number of different specialists). In this study, product complexity is the contextual variable used to represent technology or task scope. Miller and Dröge (1986) emphasize that any investigation of the determinants of structure should include the simultaneous analysis of size, technology (e.g., product complexity), and uncertainty.

Organization Size

A common perspective in the organizational structure literature is the importance of organizational size related to structural characteristics. This perspective is illustrated by the early work of Caplow (1957, 1965) and Grusky (1961), among others, who assume that large organizations are, by definition, more complex and formalized than small organizations. On the other hand, other researchers such as Blau and Scott (1962), and Zelditch and Hopkins (1961) argue that size may not be such a critical factor. Hall, Haas, and Johnson (1967) conclude that although there is some disagreement as to the relative importance of size *vis-à-vis* other context variables (e.g., product complexity and uncertainty), there does seem to be general agreement that size affects structure. Miller, Glick, and Huber (1991) further suggest that,

> Proponents of the importance of organizational size have argued that top-level managers in large organizations are forced to decentralize to overcome the basic logistical problems of controlling and coordinating many individuals and subunits, that codified rules and standard operating procedures follow this decentralization as top management seeks alternative methods of control, and that large organizations enjoy economies of scale that encourage specialization of labor (Child 1984; Daft 1986).

The historical explanation of the affect of organizational size on structure follows along these lines: as organizations grow and complexity increases the number and type of specialists also increases (i.e., specialization), which leads to an increased number of subunits, creating coordinative difficulties that require the adoption of controls, rules, policies, and formal procedures (i.e., formalization). This, in turn, delimits decision-making at lower levels of the organizational hierarchy (i.e., decentralization). Empirical evidence generally supports the argument that larger organizations tend to be have more rules (formalization), greater specialization, and more decentralization decision making (Blau and Schoenherr 1971; Child 1973; Hingings and Lee 1971; Pugh et al. 1968, 1969). Later studies by Khandwalla (1974) and Dewar and Hage (1978) confirm these basic relationships.

Although traditional arguments explaining the affects of organization size on structure seem to apply to large organizations, there is little reason to believe that smaller organizations are constrained to be centralized, informal, or staffed with generalists. Following this logic, Miller, Glick, and Huber (1991) suggest the affects of technological characteristics on organizational structure are more likely to manifest themselves in smaller organizations. This study takes an exploratory approach as to whether the relationships between SCM knowledge and organizational structure are dissimilar in small versus large firms.

Child and Mansfield (1972), in a review of the research related to the affects of size versus technology on organizational structure, argue for the Weberian view that size is of primary significance, concluding

> ...that the structural characteristics of bureaucracy - specialization of official roles, reliance on rules and documentation, an ordered delegation of authority to official positions located within an extended hierarchy - would be most prominent among greater and more complicated organizations (p. 370).

Early studies tend to give prominence to size rather than technology or other contextual variables as the major predictor of organizational structure (e.g., Blau 1970; Blau and Schoenherr 1971; Jackson and Morgan 1982; Pugh et al. 1969).

However, it is interesting to observe that the arguments giving prominence to organizational size were made at a time when achieving organizational size (i.e., growth *via* formation and acquisition of divisions) and decentralization (i.e., divisionalization) were the *avante garde* business strategies, and the complexity caused by increases in knowledge was just beginning to be felt. Since that time, and due to the relative increase in the magnitude of pressure applied to organizations *via* increasing knowledge and complexity, a fresh look and even continual monitoring of size, in relation to other context variables (e.g., product complexity and environmental uncertainty) is certainly justified.

Examples from the marketing literature illustrate the mixed results that have often been associated with organizational size. Claycomb, Germain, and Dröge (1999), in a study of JIT, find no direct relationship between JIT and size. They conclude, "...neither the resource base of large firms nor the flexibility of small firms provides an overwhelming advantage to the adoption of a JIT strategy (p. 16)." Beyer and Trice (1979) find that the impact of size on organizational structure varies according to the technology of the organization. There is also some suggestion that the impact of size may be influenced by uncertainty in the external environment (Khandwalla 1977; Mintzberg 1979), with greater uncertainty invoking greater administrative complexity in relatively large organizations.

Kimberly (1976) provides a thorough summary of the study of organization size. He argues that "...size has generally been defined in terms too global to permit its relation to organizational structure to be understood adequately (p. 570)." The conceptual definition of size is that it is one of several dimensions of an organization's context. This view comes primarily from the early English researchers, Pugh and his colleagues (the Aston group), and Child. The most common measure of size found in the literature is the number of employees in the organization. Approximately 80 percent of the research incorporating a size variable uses this measure (Kimberly 1976). The basic justification for using the number of employees as a measure for size in organizational studies is best expressed by Child (1973), who states, "It is people who are organized (p. 170)."

More recent studies incorporating organization size use of the natural or base-10 logarithm of the number of employees in order to account for the diminishing affects of size in large organizations. Kimberly (1976) provides three basic rationales for the log transformation: (1) reducing the variance in the distribution of the values of size across observations, (2) testing a hypothesis of curvilinearity between size and one or more structural variables, and (3) testing a theory in which size is hypothesized to be related with other variables in a multiplicative fashion. Of these three rationales, the first is the most common, and the rationale employed in this study. Kimberly (1976) writes,

> "The implicit justification for its [logarithm] use is that when the values of one variable are highly skewed -- as is often the case with size -- the magnitude of its resulting correlation with other variables can be very strongly affected by the extreme scores. Also, the distribution which results from a log transformation more closely approximates the normality assumption which underlies multivariate analysis (p. 583)."

The literature includes many examples of the diminishing affects of organizational size on structural dimensions (Blau and Schoenherr 1971; Child 1972; Agarwal 1979; Evers, Bohlen, and Warren 1976) further justifying the use of a logarithmic transformation. Further examples of the technical rationales for using logarithmic manipulations of size can be found in Hawley, Boland, and Boland (1965), and Hickson, Pugh, and Pheysey (1969).

In summary, firm size is included as a context variable because it has been repeatedly shown to have a pervasive impact on structure. Large organizations are typically more integrated, formalized, specialized, and decentralized (Hage 1980). With a greater potential for compartmentalization and suboptimization, integration is more critical in larger organizations (Miller and Dröge 1986). Studies also suggest that performance control systems are more common and extensive in larger organizations (Jaworski, Stathakopoulos, and Krishnan 1993). In larger organizations, performance control is more necessary in order to deal with increased complexity, greater hierarchies, and wider spans of control (Ouchi and Maguire 1975). Specialization also increases with size as larger organizations deal with relatively greater complexity and departmentalization driven by expanded specialization (Mintzberg 1979).

Finally, as Hage (1980) suggests, "One of the most consistent findings is that personnel size and centralization are negatively related (p. 391)." Larger organizations exercise greater democracy in order to reduce top management control costs and decision-making burdens. Decentralization in large organizations also allows decisions to be made at the level where the relevant information resides (Child 1973; Moch 1976). Although no specific hypotheses are proposed here, it is expected that organizational size will be positively related to each of the four elements of organization structure considered in this study: decentralization, specialization, integration, and performance control. Other research demonstrates that large firms are dissimilar from smaller firms (Miller and Dröge 1986). Therefore, this study takes an exploratory approach as to whether the hypothesized relationships between SCM knowledge and organizational structure are moderated by firm size.

Product Complexity

Complexity has proven to be an important contextual variable in the study of organizational structure (e.g.,Hall, Haas, and Johnson 1967; Zelditch and Hopkins 1961). Zelditch and Hopkins (1961) note, "what appears to be important here is complexity, which is often indicated by size but is quite distinct from it (p. 470)." While there appears to be agreement that the degree of technology or complexity in an organization's environment has an important impact on organizational structure, there have been only a limited number of attempts to operationalize the concept (Hall, Haas, and Johnson 1967). Historically, technology has been defined as the means or processes used by the organization for changing inputs into outputs. Aldrich (1972) and Scott (1981) suggest that technology is externally determined and therefore relatively uncontrollable by managers. Technology is assumed to influence structure, not *visa versa* (e.g., Perrow 1970; Thompson 1967; Woodward 1965).

The Aston researchers (Pugh et al. 1968, 1969), in the earliest research to employ technology as a control variable, construct a dimension of technology they call workflow integration. They define workflow integration as the extent to which workflow is automated, interdependent, measurable, and adaptable to other purposes. The Aston group studies find moderate relationships between workflow integration (i.e., technology) and formalization and centralization of authority. However, most of this technology-structure relationship disappears when controlling for the size of the organization

(Hickson, Pugh, and Pheysey 1969). Child and Mansfield (1972) obtain similar results, finding a relationship between technology and organizational structure that again disappears when size is employed as a control variable. Noting that the impact of technology seems to be greater in smaller organizations, these researchers speculate that the impact of technology in larger organizations is more complex because of the greater number of different technologies and divisions within larger organizations.

With the objective of obtaining more conclusive and clear results, researchers began to employ different measures of technology. Khandwalla (1974) was the first to define technology in terms of product complexity. He finds a correlation between the extent of mass-production orientation and the structural dimension of vertical integration, but not directly with centralization or the use of formal controls. Khandwalla's mass-production orientation is based on Woodward's (1965) continuum ranging from custom to small-batch to large batch to production-line to continuous-process technology. In his review of the literature on technology and structure, Singh (1985) argues that Khandwalla's (1974) mass-production measure is indeed the indicator of technology that had the greatest impact on structure.

Adding to the credibility of using measures of product complexity to represent technology, Marsh and Mannari (1981), in their study of 50 Japanese factories, conclude that technology is a more important predictor of structural differentiation and formalization than is size. However, it is noted that Singh's (1985) reassessment of the Marsh and Mannari data points out that technology was able to predict only one aspect of structural complexity (i.e., differentiation or specialization). Thus, the impact of product complexity on structure remains somewhat unclear and it is important that the technology variable be included in any model that is used to predict structure.

This study views technology in terms of product complexity. Similar to Khandwalla's (1974) mass-production orientation, this study utilizes measures of product complexity developed by Anderson (1985). In support of using product complexity as a major contextual variable, Hage and Aiken (1970) suggest that an appropriate measure of technology or complexity could be operationalized in terms of 'levels of expertise' applied to the work performed.

In summary, it is expected that product complexity will affect the elements of organizational structure. As product complexity increases, specialization is expected to increase. Increased complexity should drive increases in decentralization and the use of integrative devices. Finally, the need to monitor performance should also increase as product complexity increases. Although no specific hypotheses are proposed, it is expected that product complexity will be positively related to each of the dimensions of organizational structure: decentralization, performance control, specialization, and integration. This study takes an exploratory approach as to whether the hypothesized relationships between SCM knowledge and organizational structure are moderated by the degree of product complexity.

Environmental Uncertainty

Burns and Stalker (1961), Lawrence and Lorsch (1967), Thompson (1967), and Galbraith (1973) all call attention to the importance of the environmental in which an organization operates. Environmental uncertainty relates to the level and unpredictability of change in customer tastes, competitive behavior, technology, sources of supply, etc. (Miller and Dröge 1986). Glazer (1991) develops the notion of information intensity as a measure of environmental change or uncertainty. The importance of uncertainty is easily seen in the considerable evidence that supports the proposition that the global economy is becoming more information intensive and that this trend will continue into the foreseeable future. Explaining the continuous growth in information and its attendant uncertainty, Glazer (1991) writes,

> Among the theoretical arguments used to justify the proposition are (1) the apparently inevitable substitution of information for capital and labor combined with (2) the inherently nonscarce and seemingly unlimited renewable and regenerative aspects of information in comparison with most other commodities, which are at best scarce, nonrenewable, and usually depletable (p. 6).

To further illustrate the environmental uncertainty caused by the information explosion, consider that the efficiency of information technology has been increasing at a rate of about 25 percent per year for the last 40 years and is expected to continue to increase at that rate or better for at least the next 10 years (Haeckel 1990). Glazer (1991) notes the importance of investigating the consequences of increasing information intensiveness (i.e., uncertainty) on specific strategic and structural variables of concern to marketing scholars and practitioners. This study seeks to meet that challenge by considering the affects of environmental uncertainty on the relationships between SCM knowledge and organizational structure.

In the strategy literature the argument is made that changes in ways of conducting business are less likely to be considered in placid environments than in uncertain environments (e.g., Child 1972; Duncan 1972). Radical initiatives, like SCM knowledge practices, are more likely to be initiated as environmental uncertainty (and hence decision-making uncertainty) increases. Marketing studies show that in environments of high uncertainty organizations attempt to increase their intrafirm (Etgar 1977) and interfirm coordination (Frazier, Spekman, and O'Neal 1988) in order to buffer the effects of uncertainty. Historically, organizational theorists suggested that vertical integration was the most appropriate response to uncertainty (Williamson 1975). However, more recent arguments suggest that vertical integration is too risky, costly, and less flexible than cooperative arrangements such as SCM.

Proponents of cooperation as a means of dealing with uncertainy express the view that uncertainty in markets, customers, production processes, and competitors leads to organicity (Jauch and Kraft 1986; Miles and Snow 1978; Mintzberg 1979). Organic structures are more integrated, specialized, and decentralized than bureaucratic ones (Burns and Stalker 1961; Galbraith 1973; Lawrence and Lorsch 1967). Because uncertain environments result in highly complex, nonrepetitive tasks and administrative difficulties, a premium is placed on flexibility and adaptive organizational response. Also, because environmental instability affects the complexity and dynamism of tasks or decisions and the extent of functional interdependence, lateral integration should arise to coordinate activities. Complicated, nonroutine operations require skilled expertise, and uncertainty should relate positively to specialization. Less centralized structures are preferred because they enhance managerial ability to manuever and react quickly.

The traditional view that uncertainty relates inversely to performance control (a type of formalization) is questioned. Rapid and seemingly random changes in the environment make prediction of change very difficult. Compared to a relatively unchanging environment in which the future is easily predicted from the past, environments characterized by uncertainty require much more frequent and intensive feedback in order to generate reliable predictions (Tung 1979). Therefore, it is proposed that uncertain environments promote more extensive performance control systems that are real-time in order to allow flexibility. Galbraith (1973) supports this view *via* his observation that one means of overcoming the effects of uncertainty is the frequent and intensive collection of information to facilitate adaptation.

Celly and Frazier (1996) find empirical support for the hypothesis that environmental uncertainty contributes to coordination efforts within channels (i.e., integration). Ruekert, Walker, and Roering (1985) also suggest that when task environments are unstable and complex there is less formalization, less centralization, and more specialization. Despite widely held perceptions, however, the empirical support is less consistent (Mintzberg 1979). Therefore, inclusion of uncertainty as a context variable is important in any study of organizational structure.

In summary, uncertainty affects the relationships between SCM knowledge and the elements of organizational structure in several ways. First, as uncertainty increases, administrative tasks become more complex and nonroutine thus requiring more frequent and intensive feedback in order to generate reliable predictions (Tung 1979). In other words, performance control should increase with increases in environmental uncertainty. In addition, as discussed previously, increased uncertainty, a result of knowledge and complexity, drives increased specialization (Lawrence and Lorsch 1967) and the need for more integration mechanisms and liaison devices to promote collaboration and resolve differences (Galbraith 1973). Finally, according to historical precedence, increased uncertainty leads to a delegation of power to lower-level managers who specialize in certain complex tasks (Burns and Stalker 1961), thus increasing decentralization. Although no specific hypotheses are proposed, it is expected that environmental uncertainty will relate positively with each of the elements of organizational structure. Besides the anticipated direct affects on organizational structure, this study takes an exploratory approach as to whether the hypothesized relationships between SCM knowledge and organizational structure are moderated by the degree of environmental uncertainty.

Conclusion

In this chapter we have explored the foundations of SCM knowledge and the elements of organizational structure. In addition, a model of the relationship between SCM knowledge and organizational structure has been proposed and specific hypotheses set forth. Finally, contextual variables that may have direct affects on the elements of organizational structure, as well as potentially affecting the hypothesized relationships, have been defined and their potential impacts discussed.

Although the literature leads us to expect certain direct affects of the context variables on the hypothesized relationships, the interaction affects of these control variables is much more difficult to anticipate. For this reason, we have not made any specific hypotheses regarding either the direct or interaction affects of the context variables. Nevertheless, an exploration of these affects will provide valuable insight and provide a foundation for further research.

CHAPTER III

RESEARCH METHODOLOGY

The previous chapter examines various perspectives of epistemology, knowledge, organizational knowledge, supply chain management (SCM) knowledge, organizational structure, and the relationship between SCM knowledge and the elements of organizational structure. Research in the area of organizational knowledge began several decades ago, while the emergence of SCM research began only in the late 1980's. The merger of these concepts into a specific type of organizational knowledge called SCM knowledge is unique to this study, but relies heavily on previous research in a number of disciplines, as has already been discussed. There is no empirical research specifically related to SCM knowledge or SCM knowledge and its relationship to organizational structure.

Research questions relevant to this study have their origins in organizational research, epistemology, and more recently, the marketing discipline. A sampling of research questions similar to those in this study and providing evidence of the relevance of this study, includes; What is knowledge and what does it mean for the winning company? (Von Krogh and Roos 1996); What is the relationship between environmental uncertainty, JIT selling, and the dimensions of organizational structure? (Germain, Dröge, and Daugherty 1994); How is the concept of market knowledge competence defined and operationalized? (Li and Calantone 1998); What is the effect of increasing information intensity on marketing strategy and organizational structure? (Glazer 1991); How do organizations manage the purchasing, quality management, and customer relations components of SCM? (Tan, Kannan, and Handfield 1998); How does organizational learning relate to changes in strategic behavior? (Kuwada 1998); What is the role of the purchasing function in SCM? (Leenders, Nollet, and Ellram 1994); What are the coordination mechanisms through which firms integrate the specialist knowledge of their members? (Grant 1996b); What organizational forms and structures are best suited to effective knowledge management? (Hedlund 1994). These questions, along with others, support the relevance of this study in relationship to the existing body of research.

The purpose of this particular study is to test for relationships between SCM knowledge and organizational structure. This study also provides an analysis of the direct effects of context variables (i.e., size, product complexity, and environmental uncertainty) on organizational structure, as well as an exploratory analysis of the moderating effects of these context variables on the hypothesized relationships between SCM knowledge and organizational structure. Figure 9 summarizes the specific hypotheses to be tested in this study. The following sections explain the study and specifically examine the choice of a survey approach, the selection of the particular sample, and the use of key informants. The following section describes in detail the specific research instrument and the specific scales used to measure the criterion variables and the selected predictors. Next is a brief discussion regarding what types of techniques are most suitable in analyzing the data.

H1a:	Upstream SCM knowledge and organizational decentralization are positively related.
H1b:	Internal SCM knowledge and organizational decentralization are positively related.
H1c:	Downstream SCM knowledge and organizational decentralization are positively related.
H2a:	Upstream SCM knowledge and organizational performance control are positively related.
H2b:	Internal SCM knowledge and organizational performance control are positively related.
H2c:	Downstream SCM knowledge and organizational performance control are positively related.
H3a:	Upstream SCM knowledge and organizational specialization are positively related.
H3b:	Internal SCM knowledge and organizational specialization are positively related.
H3c:	Downstream SCM knowledge and organizational specialization are positively related.
H4a:	Upstream SCM knowledge and organizational integration are positively related.
H4b:	Internal SCM knowledge and organizational integration are positively related.
H4c:	Downstream SCM knowledge and organizational integration are positively related.

Figure 9. Summary of Hypotheses

Field Study

A field study of key informants was conducted to obtain information on SCM activities (i.e., upstream, internal, and downstream) and the elements of organizational structure (i.e., centralization, performance control, specialization, and integration), and to test the hypotheses. The unit of analysis was the specific manufacturing operation as represented by the perceptions of the respondent. In consideration of a statistical preference for multiple informants (Phillips 1981), a second informant was solicited from selected firms. In most cases, however, a single informant was selected from each organization in order to maximize the number of organizations that could be surveryed (Conant, Mokwa, and Varadarajan 1990).

Survey Approach

A particular challenge of this study is the effective measure of SCM knowledge as both an intraorganizational and interorganizational concept. The breadth of this requirement fairly precludes the use of institutional approaches, such as the use of archival documents and manuals (Blau and Schoenherr 1971; Child 1972). A survey or questionnaire approach that operationalizes the variables using multiple items for each (John and Martin 1984) appears to be the preferred method. This method is used in a number of other studies that measure variables similar to those of interest in this study (e.g., Flynn, Sakakibara, and Schroeder 1995; Germain and Dröge 1997; Li and Calantone 1998; Tan, Kannan, and Handfield 1998; Miller 1991; Varadarajan and Cuningham 1995). The survey approach is consistently used to obtain managers' perceptions of major theoretical concepts. The survey method essentially views an organization (i.e., its characteristics and behaviors) through the senses of the informant manager (Deshpandé 1982). For example, in terms of organizational structure, "The questionnaire measures tend to reflect the degree of structure experienced by organizational members in work-related activities on a day-to-day basis and, to the extent that such information is not biased, describe the emergent structure (Sathe 1978, p. 234)." Based on these arguments, the survey method seems most capable of capturing the perceived activities and relationships that represent the concepts of SCM knowledge and organizational structure. Therefore, the survey method of measurement is utilized in this study.

Sample Selection

In order to test the hypotheses, a representative sample is vital. Because of the sample size required to provide an appropriate level of statistical power, a cross-section of U.S. manufacturers was sought. The specific sampling frame consisted of 1,264 names from an "Executive" list of purchasing professionals provided by the National Association of Purchasing Management (NAPM). The list contained only manufacturing organizations spanning SIC codes 20 through 39, as described in Table 1.

Because of the breadth of information requested within the organization surveyed, as well as between the organization and its suppliers and customers, it was critical that informants possess the knowledge and experience necessary to effectively respond to all of the questions.

Several studies suggest that SCM activities tend to revolve mainly around the purchasing function (e.g., Farmer 1978; Ghingold and Johnson 1997; Handfield and Nichols 1999; Houlihan 1987; Monczka and Morgan 1998; Tan, Kannan, and Handfield 1998). In their professional role, purchasing managers typically know about, and are involved in, all of the diverse activities associated with SCM including relationships with suppliers and upstream partners, internal operations and quality, new product development activities, and activities with downstream customers. As corporate managers, purchasing executives are also able to provide a reasonable perspective related to organizational structure and other corporate activities, strategies, and objectives.

Probably no other single informant within any organization has the ability to respond as well to all of the questions related to both SCM knowledge and organizational structure. For all of these reasons, the use of high-level purchasing executives as informants in this survey is considered the best possible choice.

Data Collection

A random sample of 400 names was drawn from the aforementioned NAPM Executive list. A presurvey phone contact was undertaken to filter out those lacking sufficient knowledge to complete the questionnaire, unwilling to participate, or employed by a non-manufacturing firm. When an individual was screened out (n=159), they were replaced with another selected randomly from the list. The survey was then faxed to the participant. Reminders were faxed if no response was received within a week. Two surveys were discarded because of excessive missing values and were replaced with others on the list. All together, a total of 402 organizations were contacted. An attempt was made to secure a second respondent from a select number of organizations. A total of 78 second surveys were sent to individuals at firms in which a primary respondent had already agreed to respond to the survey. This brought to 480 the total number of surveys sent out. Of these, 227 were returned (with two discarded), for an overall response rate of 227/480=47%. The 225 usable surveys represent 208 manufacturing organizations, with 17 "doubles." The 17 "double" responses are used to test inter-rater reliability (e.g., James, Demaree, and Wolf 1984, 1993).

TABLE 1

SIC CODES AND RESPONSE DISTRIBUTION

SIC code	Description	n	%
20	Food and Kindred Products	17	8.2
21	Tobacco Products	1	0.5
22	Textile Mill Products	5	2.4
23	Apparel and Other Textile Products	3	1.4
24	Lumber and Wood Products	6	2.9
25	Furniture and Fixtures	5	2.4
26	Paper and Allied Products	12	5.8
27	Printing and Publishing	9	4.3
28	Chemicals and Allied Products	34	16.4
29	Petroleum and Coal Products	3	1.4
30	Rubber and Miscellaneous Plastics	18	8.7
31	Leather and Leather Products	0	0.0
32	Stone, Clay, and Glass Products	1	0.5
33	Primary Metal Industries	10	4.8
34	Fabricated Metal Products	21	10.1
35	Industrial Machinery and Equipment	17	8.2
36	Electronic and Other Electric Equipment	14	6.8
37	Transportation Equipment	10	4.8
38	Instruments and Related Products	9	4.3
39	Miscellaneous Manufacturing	12	5.8
--	missing	1	0.5

DESCRIPTION OF SURVEY RESPONDENTS

Title	n	%
CEO	3	1.3
VP	31	13.8
Director	144	64.0
Manager	34	15.1
Supervisor	6	2.7
Other	2	0.9
Missing	5	2.2
Total	225	

Functional Area	n	%
Administration	7	3.3
Manufacturing	11	5.2
Distribution/Logistics	8	3.8
Purchasing	155	73.1
Materials Mgmt.	9	4.2
Operations	9	4.2
Other	3	1.4
Missing	10	4.7
Total	212	

	Min.	Max.	Mean	s.d.
Annual Sales ($millions)	1.3	42000	1405.9	4187.8
Number of Employees	15	122000	4572.7	13131.7

Figure 10. Description of Survey Respondents and Organizations

Measurement

This study explores and defines the concept of SCM knowledge, a concept which has evolved from a number of related research streams including JIT and epistemology. For example, Claycomb, Germain, and Dröge (1999) wrote, "JIT is a philosophy that integrates the entire supply chain's marketing, distribution, customer service, purchasing, and production functions into one controlled process (p. 2)." Scales to measure the dimensions of SCM knowledge are created for this study. On the other hand, the elements of organizational structure are already well defined and tested in the marketing and management literatures, and are used in this study with only slight modifications. The following sections describe specifically how SCM knowledge and the elements of organizational structure are operationalized and measured.

Criterion Variables

This study adapts existing scales and concepts from previously reported studies for measuring the criterion variables -- elements of organizational structure. Data is factor analyzed to examine support for the *a priori* scales. Reliabilities of the scales are estimated by computing their coefficient α and item-to-total correlations. Existing scales from the management literature are used to measure the organizational structure dimensions of decentralization, performance control, specialization, and integration. A summary of the scales and their origins is shown in the Appendix.

The decentralization scale consists of the seventeen items displayed in Figure 11. These items assess the extent to which the organization's decision-making is decentralized. The scale is taken from Germain and Dröge (1997), but was originally developed by Miller and Dröge (1986) and based on even earlier studies by Pugh et al. (1968). Four of the seventeen items correspond exactly with Miller and Dröge's (1986) scale and ten of the seventeen items correspond exactly with Germain and Dröge's (1997) scale. Seven new items are added in order to include decisions common to modern manufacturing practices. All items included in this scale are scored on a seven-point scale ranging from decision-making authority being "above [the] chief executive" to "operatives at [the] shop level." An organization's decentralization score is determined by calculating the mean of the scores across the seventeen items. A high decentralization score indicates an organization is highly decentralized in its decision-making authority.

ORGANIZATIONAL STRUCTURE DECENTRALIZATION ITEMS

1. the number of workers required
2. internal labor disputes
3. machinery or equipment to be used
4. allocation of work among available workers
5. the types of goods to manufacture
6. the volume of production
7. disctribution service levels (e.g., fill rates)
8. the selection of suppliers
9. product quality levels
10. delivery dates to customers and priorities of orders
11. production scheduling
12. transportation scheduling
13. factory / warehouse location planning
14. new product design / research budgeting
15. new process design / research budgeting
16. EDI adoption decisions
17. inventory planning

Figure 11. Organizational Structure Decentralization Items

Performance control is measured using a scale from Miller and Dröge (1986) which is based on an scale developed earlier by Khandwalla (1974) to measure "internal performance control" in five areas using a five item scale. All items are scored on a seven-point scale ranging from "rarely used" to "frequently used." The performance control scale consists of the items displayed in Figure 12. An organization's performance control score is determined by calculating the mean of the scores across the five items. A high formalization score indicates an organization is relatively active in its formalized use of performance control devices.

ORGANIZATIONAL STRUCTURE PERFORMANCE CONTROL ITEMS

Rate the extent to which the following control devices are used to gather information about the performance of your firm.

1. a comprehensive management control and information system
2. use of cost centers for cost control
3. use of profit centers and profit targets
4. quality control of operations using sampling and other methods
5. formal appraisal of personnel

Figure 12. Organizational Structure Performance Control Items

The earliest measures of specialization are employed in a series of organizational studies, referred to as the Aston Studies, by a group of British researchers (Pugh et al. 1963; Pugh et al. 1968; Pugh and Hickson 1976). The specific scale used in this study, however, is taken from Miller and Dröge's (1986) sixteen item scale used to determine the number of activities in an organization that are performed exclusively by at least one full-time person in the organization. The scale used in this study has eleven items that correspond exactly to the Miller and Dröge (1986) scale, plus seven additional items that reflect new specializations consistent with supply chain management practices. As previously noted, specialization is thought to increase as knowledge expands. Therefore, as knowledge increases over time, technocratic specialization should also increase and descriptions of those new technocratic specializations are necessary in order to capture the specialization that currently exists within the firm. The eighteen items used to comprise the specialization scale are shown in Figure 13. Respondents were asked to answer "yes" or "no" if the listed activity is dealt with exclusively by at least one full-time person in the organization. A "yes" answer on any of the items indicates the particular activity is specialized within the organization (i.e., it is exclusively performed by at least one full-time person). An answer of "no" on any activity indicates low specialization of the activity within the organization (i.e., the activity is distributed among organizational members). "Yes" answers are scored as one, and "no" answers are scored as zero. An organizations overall specialization score is determined by summing the scores for all eighteen items. A high specialization score indicates an organization is comprised of a relatively large number of specialists. This variable is treated as interval-scaled for data analysis.

ORGANIZATIONAL STRUCTURE SPECIALIZATION ITEMS

1. advertising / promotion
2. developing / training personnel
3. production scheduling
4. sales forecasting
5. new process design / research
6. warehouse location planning
7. warehouse layout planning
8. new product design / research
9. inventory plannning and control
10. after sales service
11. international purchasing
12. market research
13. internal quality control
14. factory location planning
15. factory layout planning
16. transportation scheduling
17. materials handling
18. supplier quality control

Figure 13. Organizational Structure Specialization Items

Integration is measured using a three item scale taken from Miller and Dröge (1986). The items comprising the scale measure the usage of cross-functional committees, temporary task forces, and liaison personnel in assuring the compatibility of decisions across functional areas (Miller 1983; Miller and Dröge 1986). All items are scored on a seven-point scale, ranging from "rarely" to "frequently." An organizations integration score is determined by calculating the mean of the scores across the three items shown in Figure 14. A high integration score indicates an organization is relatively active in its use of integrative mechanisms.

ORGANIZATIONAL STRUCTURE INTEGRATION ITEMS

In assuring the compatibility among decisions in one area (e.g., purchasing) with those in other areas (e.g., production), to what extent are the following integrative mechanisms used?

1. Interdepartmental committees which are set up to allow departments to engage in joint decision-making on an ongoing basis.
2. Cross-functional teams which are temporary bodies set up to facilitate interdepartmental collaboration on a specific project.
3. Liaison personnel whose specific job it is to coordinate the efforts of several departments for the purposes of a specific project.

Figure 14. Organizational Structure Integration Items

Predictor Variables

SCM knowledge is measured by the extent of SCM practices employed by the firm. This approach is similar to that taken by Li and Calantone (1998) in their recent study of market knowledge competence. Sinkula, Baker, and Noordewier (1997) also suggest that organizational knowledge ultimately manifests itself through both internal and external organizational actions. Fiol and Lyles (1985) argue that the measurement of activities and skills provides a sufficient measure of organizational learning. In order to take into account the interorganizational dimensions of SCM knowledge, the measurement of SCM knowledge was divided into three separate dimensions: upstream SCM knowledge (i.e., SCM activities related to upstream suppliers), internal SCM knowledge (i.e., SCM activities conducted within the firm), and downstream SCM knowledge (i.e., SCM activities related to downstream customers). The scales used are based on those developed by Sakakibara, Flynn, and Schroeder (1993; see also Sakakibara et al. 1997). The original development of these scales is based on a review of the conceptual literature, the empirical literature, and a number of plant visits (Sakakibara et al. 1997). A unique aspect of this study is the division of the scales into the three dimensions of SCM knowledge (i.e., upstream, internal, and downstream). The upstream and downstream scales used in this study are nearly identical, modified only to reflect the unique perspectives of upstream and downstream application. See the Appendix for a comparison of the scales used in this study with the original scales upon which they are based.

Respondents are asked to rate their firm's application (or use) of knowledge in each of the areas listed. As further clarification, respondents are instructed to respond not based on whether their firm places a high value on knowledge, but on whether their firm is currently applying a high level of knowledge. All items are scored on a seven-point scale ranging from "low application of knowledge" to "high application of knowledge." The scales used for SCM knowledge are displayed in Figure 15.

SCM KNOWLEDGE COMPETENCE ITEMS

Upstream SCM knowledge (8 items total). Knowledge applications with/from suppliers.

- information from alternative suppliers on their product quality levels
- joint co-design of products with suppliers
- information from suppliers that lowers your production costs
- information from suppliers that improves inbound delivery and inventory
- information from suppliers that improves your product quality
- suppliers' application of your firm's production plans (your firm's sharing of production plans with suppliers
- suppliers' application of how you use their goods/components in your manufacturing processes
- warehouse staging systems proximate to your firm that provide you with inbound JIT-type delivery

Internal SCM knowledge (8 items total). Internal knowledge application.

- mechanisms such as statistical process control, Pareto charts, and other analytic tools to improve the quality of processes and products
- "Total Preventive Maintenance" methods
- demand-pull support systems
- methods for reducing machine set up times
- direct labors' understanding of machinery/processes through cross-training
- direct labors' understanding of spotting defects / erros in products / processes
- cellular plant layout
- kanban support systems

Downstream SCM knowledge (8 items total). Knowledge application with/from customers.

- information from customers on their expected product quality levels
- joint co-design of products with customers
- information from customers on how they use your goods/component parts
- outbound warehouse staging systems proximate to customers to provide them with JIT-type delivery
- information from customers on their future production plans
- information from customers that lowers your production costs
- information from customers that improves delivery and inventory
- information from customers that improves your product quality

Figure 15. SCM Knowledge Items

Traditional scale development analysis including factor analysis, coefficient α, and item-to-total correlations is used to test the scale and to assess its reliability. An organization's overall score for each of the dimensions of SCM knowledge is determined by calculating the mean of the scores for each dimension of the multi-item scale. A high SCM knowledge score indicates that an organization has a high degree of SCM knowledge application.

Context Variables

Several organizational context variables are measured in this study because of their recognized and/or anticipated influence on organizational structure (e.g., Jaworski and Kohli 1993; Narver and Slater 1990) as well as their potential moderating influence on the hypothesized relationships between SCM knowledge and organizational structure. In particular, measures of organizational size, environmental uncertainty, and product complexity are obtained. While no relationships involving context variables are hypothesized, the context variables will be analyzed for their possible direct effects on organizational structure as well as their moderating influences on the hypothesized relationships.

Previously reported methods for measuring the three contextual variables are employed in the present study. Organizational size is determined by the number of employees at the surveyed business unit's location. This is a common method of measuring organizational size. Although measures of annual sales might also be employed, number of employees is normally easier to obtain and is highly correlated with sales volume (Smith, Guthrie, and Chen 1989). The number of employees is obtained from the respondent in answer to the question, "number of employees?" As is common in the management literature (e.g., Kimberly 1976), the statistical analysis will incorporate the natural logarithm of the number of employees. A logarithmic transformation corrects for the diminishing effect of size on structure as size increases (Blau 1970).

Environmental uncertainty is assessed using a scale from Celly and Frazier (1996). Similar scales are successfully used in a number of other studies (e.g. Anderson 1985; Khandwalla 1977; Miller and Dröge 1986). The specific ten item scale used in this study has five items that correspond directly with the Celly and Frazier (1996) scale. An additional four items correspond with Miller and Dröge's (1986) scale, and one item is unique to this study. The one unique item relates to changes in logistics processes and is added based on the high logistics content of SCM practices. Respondents are asked to assess the environment in which their firm operates from "stable environment" to "dynamic environment." Figure 16 displays a list of the specific scale items. The uncertainty under which an organization operates is determined by calculating the mean of the scores across the ten items. A high uncertainty score indicates an organization operates within a relatively dynamic and uncertain environment.

ENVIRONMENTAL UNCERTAINTY ITEMS

1. sales are (1) predictable versus (7) unpredictable
2. market shares are (1) stable versus (7) volatile
3. market trends are (1) easy to monitor versus (7) difficult to monitor
4. logistics processes change (1) slowly versus (7) rapidly
5. industry volume is (1) stable versus (7) volatile
6. competitor actions are (1) easy to predict versus (7) difficult to predict
7. products become obsolete (1) slowly versus (7) quickly
8. core production processes change (1) slowly versus (7) rapidly
9. sales forecasts are likely to be (1) accurate versus (7) inaccurate
10. new products are introduced (1) infrequently versus (7) frequently

Figure 16. Environmental Uncertainty Items

Finally, product complexity ias measured using a scale developed and refined by Anderson (1985). Using a five-point scale, respondents are asked to assess the complexity of the products they manufacture from "low complexity" to "high complexity." Scale items are displayed in Figure 17. Overall product complexity is determined by calculating the mean of the scores across the five items. A high product complexity score indicates an organization produces products with a relatively high content of embedded knowledge or complexity.

PRODUCT COMPLEXITY ITEMS

1. products are (1) non-technical versus (7) technical
2. products have (1) low engineering content versus (7) high engineering content
3. products are (1) not very sophisticated versus (7) very sophisticated
4. products are (1) simple versus (7) complex
5. salespeople are (1) easily trained about products versus (7) not easily trained about products

Figure 17. Product Complexity Items

A copy of the entire survey instrument is found in the Appendix to this manuscript.

Data Analysis

This study addresses the question: Is there a relationship between SCM knowledge and organizational structure? In answering this question, this study empirically examines the conceptualized relationships between multiple dimensions of SCM knowledge and selected elements of organizational structure.

To meet this objective, hypotheses are presented that posit relationships between the dimensions of SCM knowledge (i.e., upstream, internal, and downstream) and the major elements of organizational structure (i.e., centralization, performance control, specialization, and integration).

In the next chapter, the hypotheses are investigated using multiple regression techniques. Regression analysis allows examination of the relationship between SCM knowledge and organizational structure. The data for these analyses was obtained *via* the field study described earlier. The regression models are designed to test the hypothesized relationships. Centralization, performance control, specialization, and integration, the major elements of organizational structure, are set as the criterion variables. The effect of the predictor variables (i.e., upstream, internal, and downstream SCM knowledge) is assessed while controlling for size, environmental uncertainty, and product complexity. Finally, an examination of the moderating effects of the organizational context variables (i.e., organizational size, environmental uncertainty, and product complexity) is performed.

CHAPTER IV

RESEARCH FINDINGS

This chapter describes the findings from the empirical examination of the conceptualized relationships between the dimensions of SCM knowledge and the selected elements of organizational structure. The research findings are presented in four sections. The first section describes the reliability assessment of the SCM knowledge scales, the organizational structure scales, and the context variable scales. Descriptive statistics of the study's variables are provided in the second section. In the third section, hypotheses are tested using the elements of organizational structure as criterion variables. Finally, the effects of the context variables on organizational structure, as well as any moderating effects of the context variables on the hypothesized relationships between SCM knowledge and organizational structure are explored.

Scale Reliabilities

SCM Knowledge

As explained in the previous chapter, the three *a priori* dimensions of SCM knowledge were identified as follows:

1. Upstream SCM Knowledge
2. Internal SCM Knowledge
3. Downstream SCM Knowledge

In order to examine the *a priori* dimensionality of the SCM knowledge scale, traditional scale development analysis is performed on the survey responses. First, factor analysis is conducted. The responses to the scale items are subjected to a principal components factor analysis with an orthogonal rotation. Examination of the scree plot supports the use of a three factor model. However, interpretation of the initial analysis results in the elimination of survey items E.22 (suppliers' application of your firm's production plans), E.23 (suppliers' application of how you use their goods/components in your manufacturing processes), and E.24 (warehouse staging systems proximate to your firm that provide you with inbound JIT-type delivery) due to their relatively poor factor loadings. Further, because these three items uniquely represent SCM activites that take place within supplier organizations (i.e., activities that may be outside the respondent's view), respondents may not have possessed the knowledge to properly answer these questions or may have misunderstood the questions (e.g., should the answer be based on the number of suppliers performing these activities or on the dollar volume of purchases for which these activities are performed). The final results of a three factor model were found to be interpretable with all factor loadings significant at the .05 significance level or better. Given the sample size and level of significance, a power level of at least 80 percent is obtained (conservatively assuming the standard errors to be twice those of conventional correlation coefficients) (Hair, et al. 1995, p.385). The scale items, factor loadings, and factor descriptions are presented in Table 2.

The first factor, a measure of SCM knowledge with/from downstream customers, accounted for 31.5% of the variance. The second factor, a measure of the degree of internal SCM knowledge, accounted for an additional 11.0% of variance. The final factor, measuring the degree of SCM knowledge with/from upstream suppliers, accounted for another 9.3% of the variance. In total, this three factor solution explained 51.8% of the variance.

TABLE 2

SCM KNOWLEDGE
FACTOR ANALYSIS LOADINGS

Survey Item	Item Description	Factors 1	2	3
	Factor 1: Downstream SCM Knowledge			
E.09	Information from customers on expected product quality levels	**.66**	.18	.01
E.10	Joint co-design of products with customers	**.61**	.06	.11
E.11	Information from customers on how they use your goods/parts	**.70**	.08	.01
E.12	Outbound warehouse staging systems proximate to customers to provide them with JIT-type delivery	**.42**	.08	.22
E.13	Information from customers on their future production plans	**.58**	.16	.22
E.14	Information from customers that lowers your production costs	**.60**	.06	.40
E.15	Information from customers that improves outbound delivery and inventory management	**.58**	.17	.43
E.16	Information from customers that improves product quality	**.56**	.00	.22
	Factor 2: Internal SCM Knowledge			
E.01	Mechanisms such as statistical process control, Pareto charts, & other analytic tools to improve the quality of processes/products	.38	**.67**	.01
E.02	"Total Preventive Maintenance" methods	.41	**.60**	.04
E.03	Demand-pull support systems	-.03	**.64**	.28
E.04	Methods for reducing machine set up times	.29	**.63**	.21
E.05	Direct labors' understanding of machinery/processes	.35	**.65**	.02
E.06	Direct labors' understanding of spotting defects/errors	.37	**.63**	.03
E.07	Cellular plant layout	-.16	**.68**	.14
E.08	Kanban support systems	-.15	**.68**	.18
	Factor 3: Upstream SCM Knowledge			
E.17	Information from alternative suppliers on product quality levels	.32	.25	**.53**
E.18	Joint co-design of products with suppliers	.11	.22	**.73**
E.19	Information from suppliers that lowers your production costs	.16	.16	**.81**
E.20	Information from suppliers that improves inbound delivery and inventory management.	.25	.01	**.82**
E.21	Information from suppliers that improves your product quality.	.12	.11	**.80**
	Eigenvalue	6.61	2.32	1.95
	Percent Variance Explained	31.50	11.00	9.30
	Cumulative Variance Explained	31.50	42.50	51.80

TABLE 3

COEFFICIENT α AND ITEM-TO-TOTAL CORRELATIONS FOR DIMENSIONS OF SCM KNOWLEDGE

Survey Item	Item Description	Item-to-Total Correlation
	Factor 1: Downstream SCM Knowledge: Coefficient α = .80	
E.09	Information from customers on their expected product quality levels	.48
E.10	Joint co-design of products with customers	.51
E.11	Information from customers on how they use your goods/parts	.50
E.12	Outbound warehouse staging systems proximate to customers to provide them with JIT-type delivery	.36
E.13	Information from customers on their future production plans	.57
E.14	Information from customers that lowers your production costs	.65
E.15	Information from customers that improves outbound delivery and inventory management	.60
E.16	Information from customers that improves your product quality	.48
	Factor 2: Internal SCM Knowledge: Coefficient α = .83	
E.01	Mechanisms such as statistical process control, Pareto charts, & other analytic tools to improve the quality of processes/products	.63
E.02	"Total Preventive Maintenance" methods	.58
E.03	Demand-pull support systems	.53
E.04	Methods for reducing machine set up times	.60
E.05	Direct labors' understanding of machinery/processes	.60
E.06	Direct labors' understanding of spotting defects/errors	.58
E.07	Cellular plant layout	.49
E.08	Kanban support systems	.51
	Factor 3: Upstream SCM Knowledge: Coefficient α = .86	
E.17	Information from alternative suppliers on their product quality levels	.55
E.18	Joint co-design of products with suppliers	.64
E.19	Information from suppliers that lowers your production costs	.74
E.20	Information from suppliers that improves inbound delivery and inventory management	.74
E.21	Information from suppliers that improves your product quality	.70

One measure of internal consistency of a scale is coefficient α (Peter 1979). Coefficient α for the twenty-one items used in the final SCM knowledge scale was .88, indicating the scale has a high level of internal consistency or reliability. Coefficient α and item-to-total correlations for each of the three dimensions of SCM knowledge are displayed in Table 3. The relatively high correlations (ranging from .36 to .74) indicate that the items are part of the domain of the SCM knowledge construct. However the correlations are not so high as to indicate redundancy of the items.

Organizational Structure

This study adapts existing scales and concepts from previously reported studies for measuring the elements of organizational structure: performance control, decentralization, specialization, and integration. The α and correlations for each of these variables are shown in Tables 4 through 6.

Decentralization. The structural dimension of decentralization is measured using a scale originally developed by Miller and Dröge (1986) and refined by Germain and Dröge (1997). Seven new items are added to the scale in order to include decisions common to modern manufacturing practices. An exploratory factor analysis of the scale yields a scree plot supporting a two factors solution. Although not expected, this result is not inconsistent with the findings of Germain, Dröge, and Daugherty (1994) who suggest that decentralization consists of two distinct dimensions: operations decentralization and scheduling decentralization. When factor analyzed along these two dimensions, and eliminating items N.1, N.2, N.3, N.5, N.8, N.9, and N.13 due to low communalities (Hair et al. 1995, p. 387), factor 1 (scheduling decentralization) accounted for 38.4% of the variance, and factor 2 (operations decentralization) accounted for 16.3% of the variance. Further analysis led to the elimination of item N.6 and N.7 due to low communalities, and a focus on factor 1 (scheduling decentralization) only. The remaining six items (N.4, N.10, N.11, N.12, N.16, and N.17) account for 49.1% of the variance in a single factor solution. The relatively high coefficient α and item-to-total correlations, shown in Table 4, indicate reliability in the refined scale.

TABLE 4

DECENTRALIZATION SCALE
COEFFICIENT α AND ITEM-TO-TOTAL CORRELATIONS

Survey Item	Item Description	Item-to-Total Correlation
Decentralization: Coefficient α = .78		
N.04	Allocation of work among available workers	.46
N.10	Delivery dates to customers and priorities of orders	.51
N.11	Production scheduling	.74
N.12	Transportation scheduling	.66
N.16	EDI adoption process.	.36
N.17	Inventory planning	.46

Performance Control. The structural dimension of performance control is measured using an existing scale developed by Miller and Dröge (1986). Factor analysis of the scale confirms the *a priori* suggestion of a single factor (based on the latent root criterion -- only eigenvalues greater than 1.0 are considered). The single factor accounts for 52.2% of the variance. The relatively high coefficient α and item-to-total correlations, shown in Table 5, indicate reliability in the scale.

TABLE 5

PERFORMANCE CONTROL SCALE
COEFFICIENT α AND ITEM-TO-TOTAL CORRELATIONS

Survey Item	Item Description	Item-to-Total Correlation
Performance Control: Coefficient α = .78		
F.01	A comprehensive management control and information system	.58
F.02	Use of cost centers for cost control	.62
F.03	Use of profit centers and profit targets	.57
F.04	Quality control of operations using sampling and other methods	.50
F.05	Formal appraisal of personnel	.44

Integration. The structural dimension of integration is measured using an existing scale developed by Miller and Dröge (1986). Factor analysis of the scale confirms *a priori* evidence of a single factor (based on the latent root criterion). The single factor model accounts for 73.0% of the variance. The relatively high coefficient α and item-to-total correlations, shown in Table 6, indicate reliability in the scale.

TABLE 6

INTEGRATION SCALE
COEFFICIENT α AND ITEM-TO-TOTAL CORRELATIONS

Survey Item	Item Description	Item-to-Total Correlation
Integration: Coefficient $\alpha = .81$		
J.01	Interdepartmental committees which are set up to allow departments to engage in joint decision-making on an ongoing basis	.70
J.02	Cross-functional teams which are temporary bodies set up to facilitate interdepartmental collaboration on a specific project	.70
J.03	Liaison personnel whose specific job it is to coordinate the efforts of several departments for the purposes of a specific project	.60

Context Variables

This study adapts existing scales and concepts from previously reported studies for measuring the context variables of environmental uncertainty and product complexity. Organization size, the third context variable, is simply the number of people employed by the respondent's business unit. The number of employees was obtained from the respondent in answer to the question, "number of employees?" As is common in the management literature (e.g., Kimberly 1976), the statistical analysis incorporates the natural logarithm of the number of employees. A logarithmic transformation corrects for the diminishing effect of size on structure as size increases (Blau 1970).

Environmental Uncertainty. The context variable environmental uncertainty is measured using a scale from Celly and Frazier (1996). The ten item scale used in this study has five items that correspond directly with the Celly and Frazier (1996) scale, an additional four items from Miller and Dröge's (1986) scale, and one item unique to this study. An exploratory factor analysis of the scale yields a three factor structure, based on the latent root criterion using only eigenvalues greater than 1. Interpretation of the factors suggests that factor 1, accounting for 36.2% of the variance, provides the best general measure of environmental uncertainty. Interpretation of factor 2 (survey items B.4 and B.8) suggests it represents uncertainty related only to internal processes, and factor 3 (survey items B.7 and B.10) appears to represent uncertainty related only to product change. Those items not included in factor 1 (items B.4, B.7, B.8, and B.10) are eliminated from further analysis, and those items included in factor 1 are subjected to another factor analysis, which confirms a single factor, accounting for 51.3% of the variance. The relatively high coefficient α and item-to-total correlations, shown in Table 7, indicate reliability in the refined scale.

TABLE 7

ENVIRONMENTAL UNCERTAINTY SCALE
COEFFICIENT α AND ITEM-TO-TOTAL CORRELATIONS

Survey Item	Item Description	Item-to-Total Correlation
Environmental Uncertainty: Coefficient α = .81		
B.01	Sales are predictable / unpredictable	.67
B.02	Market shares are stable / unstable	.55
B.03	Market trends are easy to monitor / hard to monitor	.58
B.05	Industry volume is stable / volatile	.56
B.06	Competitor actions are easy to predict / difficult to predict	.45
B.09	Sales forecasts are likely to be accurate / inaccurate	.61

Product Complexity. The context variable product complexity is measured using an existing scale from Anderson (1985). Factor analysis of the scale confirms *a priori* evidence of a single factor (based on the latent root criterion). The single factor model accounts for 76.7% of the variance. The relatively high coefficient α and item-to-total correlations, shown in Table 8, indicate reliability in the scale.

TABLE 8

PRODUCT COMPLEXITY SCALE
COEFFICIENT α AND ITEM-TO-TOTAL CORRELATIONS

Survey Item	Item Description	Item-to-Total Correlation
Product Complexity: Coefficient α = .92		
H.01	Products are non-technical / technical	.83
H.02	Products have low / high engineering content	.76
H.03	Products are / are not very sophisticated	.89
H.04	Products are simple / complex	.87
H.05	Salespeople are easily / not easily trained about product	.65

Descriptive Statistics

SCM Knowledge Variables

Table 9 summarizes the number of items, mean scores, standard deviations, ranges, and minimum and maximum values for each of the dimensions of SCM knowledge. The composite scores for each of the dimensions of SCM knowledge are the mean summates of the items making up each of the scales. The dispersion of the survey responses comprising each dimension of SCM knowledge is adequately distributed, providing variance across the sample and allowing examination of the hypothesized relationships.

While the means of the dimension scores are fairly consistent, it is worth noting that the mean score for upstream SCM knowledge is the highest (4.42). This is not unexpected given the relative importance of working with upstream suppliers as well as the potential bias and/or knowledge of respondents (i.e., purchasing professionals) towards upstream SCM knowledge.

TABLE 9

DESCRIPTIVE STATISTICS
FOR SCM KNOWLEDGE, ORGANIZATIONAL STRUCTURE
AND CONTEXT VARIABLES

	No. of Items	Mean	s.d.	Range	Min.	Max.
Upstream SCM knowledge	5	4.49	1.10	5.88	1.00	6.88
Internal SCM knowledge	8	4.13	1.10	5.12	1.25	6.38
Downstream SCM knowledge	8	4.28	0.94	5.12	1.25	6.38
Decentralization	6	4.40	0.69	5.00	1.00	6.00
Performance Control	5	5.13	1.14	5.00	2.00	7.00
Specialization	18	9.95	4.80	18.00	0.00	18.00
Integration	3	4.42	1.55	6.00	1.00	7.00
Size (natural logarithm)	1	2.96	0.75	3.91	1.18	5.09
Environmental Uncertainty	6	3.85	0.96	5.50	1.00	6.50
Product Complexity	5	4.48	1.50	6.00	1.00	7.00

Organizational Structure Variables

Table 9 also summarizes the number of items, mean scores, standard deviations, ranges, and minimum and maximum values for each of the dimensions of organizational structure: decentralization, performance control, specialization, and integration. The composite scores are the mean summates of the items making up each of the scales, except for specialization.

For the most part, the mean scores of these measures are close to the 4.0 mathematical midpoint of the scales (9.0 midpoint for specialization). The main departure from the midpoint is in the performance control mean (5.13). Nevertheless, the relatively high mean score for performance control is insufficient to adversely affect the analyses and merely suggests that the surveyed organizations are relatively active in their use of performance measures. This finding is not unexpected given the emphasis placed on performance measurement and control in the popular business literature.

An additional explanation is needed for the specialization variable. As described in Chapter 3, specialization is measured using a "yes" / "no" scale. The composite score for specialization was computed by replacing "yes" responses with 1.00 and "no" responses with 0.00 and then summing the responses for all 18 items in the scale. Similar to the other organizational structure variables, the mean score for specialization is close to its midpoint of 9.0. Finally, the dispersion of the survey responses comprising each variable are adequately distributed to provide sufficient variance across the sample to allow examination of the hypothesized relationships.

Context Variables

Table 9 summarizes the number of items, mean scores, standard deviations, ranges, and minimum and maximum values for each of the context variables: size, environmental uncertainty, and product complexity. Size is computed as the natural logarthim of the number of employees, as reported by the respondent. The composite scores for environmental uncertainty and integration are the mean summates of the items making up each of the scales. The mean scores for both environmental uncertainty and integration are reasonably close to the mathematical midpoint of 4.0, and the dispersion of the survey responses comprising each of the variables is adequately distributed to provide variance across the sample and allow examination of the hypothesized relationships.

Interrater Agreement

All of the analyses employed in this study to test the relationships between the dimensions of SCM knowledge and the elements of organizational structure are based upon the "collapsed" data (n=208). However, as previously described, the total number of surveys assessed was 225 (n=17 "doubles"). These 17 “doubles” are used to assess the agreement between respondents within the same organization and thereby verify the appropriateness of utilizing the collapsed data (James, Demaree, and Wolf 1984, 1993). Table 10 shows the results of the analysis of the 17 doubles (n=34). An interrater agreement score is calculated for each variable, with a score of greater than .70 considered acceptable. Clearly, these scores support the results of this study, as they range from .72 to .93.

TABLE 10

ANALYSIS OF INTERRATER AGREEMENT

Variable	Interrater Agreement Score
Upstream SCM Knowledge	.93
Internal SCM Knowledge	.91
Downstream SCM Knowledge	.73
Decentralization	.94
Performance Control	.85
Specialization	.72
Integration	.76
Environmental Uncertainty	.88
Product Complexity	.82

Correlation Analysis

Table 11 is a correlation matrix of all variables examined in this study: the dimensions of SCM knowledge (i.e., upstream, internal, and downstream), the dimensions of organizational structure (i.e., decentralization, performance control, specialization, and integration), and the context variables (i.e., size, environmental uncertainty, and product complexity). A general inspection of the correlation matrix appears to generally support the findings of the hypotheses tests to be discussed later. That is, there are relatively high correlations between the dimensions of SCM knowledge and the elements of organizational structure. There are also relatively high correlations between each of the context variables and the elements of organizational structure.

TABLE 11

CORRELATION MATRIX OF
SCM KNOWLEDGE, ORGANIZATIONAL STRUCTURE,
AND CONTEXT VARIABLES

		SCMU	*SCMI*	*SCMD*	*DEC*	*PERC*	*SPEC*	*INT*	*SIZE*	*ENVU*	*PCMX*
SCMU	Upstream SCM Knowledge	-									
SCMI	Internal SCM Knowledge	.39a	-								
SCMD	Downstream SCM Knowledge	.49a	.42a	-							
DEC	Decentralization	.12c	.14c	-.10	-						
PERC	Performance Control	.38a	.55a	.38a	.20a	-					
SPEC	Specialization	.25a	.29a	.14b	.29a	.38a	-				
INT	Integration	.40a	.49a	.34a	.25a	.53a	.34a	-			
SIZE	Size	.04	.20a	.00	.41a	.25a	.63a	.28a	-		
ENVU	Environmental Uncertainty	.00	-.13c	-.24a	-.01	-.11	-.01	-.01	-.06	-	
PCMX	Product Complexity	.13c	.36a	.24a	.15b	.37a	.28a	.34a	.17b	.09	-

a $p \leq .01$; b $p \leq .05$; c $p \leq .10$

Hypotheses Testing

Four hypotheses are developed in the previous chapter. All the hypotheses are tested using multiple regression. Given the sample size, an *a priori* significance level less than or equal to 0.05 was determined to be suitable. The criterion variables for each of the hypotheses are the four dimensions of organizational structure: decentralization, performance control, specialization, and integration. Predictor variables include the dimensions of SCM knowledge (upstream, internal, and downstream) and the context variables (size, environmental uncertainty, and product complexity). The results of testing these hypotheses are presented in this section.

Hypothesis 1: Decentralization

In terms of decentralization, it is hypothesized that:

H1a: Upstream SCM Knowledge and Decentralization are positively related.
H1b: Internal SCM Knowledge and Decentralization are positively related.
H1c: Downstream SCM Knowledge and Decentralization are positively related.

These hypotheses generally postulate that firms with relatively high degrees of SCM knowledge are more likely to be relatively decentralized. The results of the regression analysis testing these hypotheses are displayed in Table 12.

As illustrated in Table 12, the overall regression model is significant ($F = 8.27$, $p<.0001$) with an R^2 value indicating that 21.3% of the variance in the relationship is explained by the model. Nevertheless, no support is found for either H1a (upstream SCM knowledge and decentralization) or H1b (internal SCM knowledge and decentralization). Also, although the relationship between downstream SCM knowledge and decentralization is significant, no support is found for H1c since the sign of the parameter estimate is opposite (i.e., negative) from what is hypothesized. Although unexpected, an explanation may be found in the overwhelming effect of organization size on decentralization which, arguably, obscures the effects of SCM knowledge on decentralization. Further discussion of these results is found in the next chapter.

TABLE 12

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND CONTEXT VARIABLES
WITH DECENTRALIZATION

	Variable	Expected Sign	Beta	t	Prob. t
H1a	Upstream SCM Knowledge	+	.15	1.96	.0512
H1b	Internal SCM Knowledge	+	.04	.44	.6636
H1c	Downstream SCM Knowledge	+	-.24	-2.96	.0035
	Size		.37	5.42	.0000
	Environmental Uncertainty		-.06	-.89	.3759
	Product Complexity		.12	1.65	.0999

Model F = 8.28
Prob. F = .0000
R^2 = .213
Adjusted R^2 = .188

The measures of organization size, environmental uncertainty, and product complexity are included in the regression analysis as predictor variables to test their direct effects on decentralization. As illustrated in Table 12, the results indicate that among the context variables only size exhibits a significant positive relationship with decentralization. Although no hypotheses are made concerning relationships between these context variables and decentralization, these findings are, nevertheless, somewhat different from *a priori* expectations that each of the context variables are positively related to decentralization.

Hypothesis 2: Performance Control

In terms of performance control, it is hypothesized that:

H2a: Upstream SCM Knowledge and Performance Control are positively related.
H2b: Internal SCM Knowledge and Performance Control are positively related.
H2c: Downstream SCM Knowledge and Performance Control are positively related.

These hypotheses, taken together, generally suggest that firms reporting relatively high levels of SCM knowledge are more likely to have established performance controls. The results of the regression analysis testing these hypotheses are displayed in Table 13. The dimensions of SCM knowledge are the predictor variables. The overall regression model is significant ($F = 22.48$, $p<.0001$) with an R^2 value indicating that 41.4% of the variance in the relationship is explained by the model.

Only H2c is not supported. That is, the estimate of the effect of downstream SCM knowledge on performance control is not significant. H2a and H2b are supported. The estimate of the effect of upstream SCM knowledge on performance control and internal SCM knowledge on performance control are significant.

Hypothesis 3: Specialization

In terms of specialization, it is hypothesized that:

H3a: Upstream SCM Knowledge and Specialization are positively related.
H3b: Internal SCM Knowledge and Specialization are positively related.
H3c: Downstream SCM Knowledge and Specialization are positively related.

These hypotheses posit that relatively high levels of SCM knowledge are predictive of relatively high degrees of specialization. The results of the regression analysis testing these hypotheses are displayed in Table 14. The predictor variables are the dimensions of SCM knowledge (i.e., upstream, internal, and downstream). The regression model is statistically significant ($F = 28.62$, $p<.0001$) with an R^2 value indicating the model explains 47.9% of the variance in the relationships.

Related to the hypotheses, only the estimate of the effect of upstream SCM knowledge on specialization is significant, thus supporting H3a. No support is found for either H3b (internal SCM knowledge and specialization) or H3c (downstream SCM knowledge and specialization).

Measures of organization size, environmental uncertainty, and product complexity are included in the regression analysis as predictor variables to test their relationship with specialization. As illustrated in Table 14, the results indicate that organization size is a significant predictor of specialization. In fact, organization size is the strongest predictor of specialization among the variables included in the model. Product complexity is also a significant predictor of organizational specialization. No support, however, is found for a relationship between environmental uncertainty and specialization.

TABLE 14

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND CONTEXT VARIABLES
WITH SPECIALIZATION

	Variable	Expected Sign	Beta	t	Prob. t
H3a	Upstream SCM Knowledge	+	.18	2.86	.0047
H3b	Internal SCM Knowledge	+	.08	1.28	.2024
H3c	Downstream SCM Knowledge	+	-.02	-.30	.7663
	Size		.58	10.69	.0000
	Environmental Uncertainty		-.01	-.13	.8961
	Product Complexity		.14	2.38	.0185

Model F = 28.62
Prob. F = .0000
R^2 = .479
Adjusted R^2 = .462

Hypothesis 4: Integration

In terms of integration, it is hypothesized that:

H4a: Upstream SCM Knowledge and Integration are positively related.
H4b: Internal SCM Knowledge and Integration are positively related.
H4c: Downstream SCM Knowledge and Integration are positively related.

These hypotheses generally suggest that firms exhibiting relatively high SCM knowledge will also be relatively integrated. The results of the regression analysis testing these hypotheses are displayed in Table 15. Measures of the dimensions of SCM knowledge are the predictor variables.

The regression model is statistically significant ($F = 18.39$, $p<.0001$) with 37.0% of the variance in the relationship being explained by the model, as evidenced by the R^2

value. The estimate of the effect of upstream SCM knowledge on integration and internal SCM knowledge on integration are significant, thus supporting both H4a and H4b. The estimate of the effect of downstream SCM knowledge on integration is not significant, thus providing no support for hypothesis H4c.

TABLE 15

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND CONTEXT VARIABLES
WITH INTEGRATION

	Variable	Expected Sign	Beta	t	Prob. t
H4a	Upstream SCM Knowledge	+	.20	2.88	.0044
H4b	Internal SCM Knowledge	+	.30	4.21	.0000
H4c	Downstream SCM Knowledge	+	.08	1.11	.2674
	Size		.18	3.05	.0026
	Environmental Uncertainty		.02	.26	.7945
	Product Complexity		.17	2.70	.0075

Model F = 18.39
Prob. F = .0000
R^2 = .370
Adjusted R^2 = .350

The context variables are also included in the regression analysis to test for any direct effects on integration. As seen in Table 15. the results indicate that both organization size and product complexity are significant predictors of integration. The results also indicate that environmental uncertainty is not a significant predictor of integration.

Moderating Effects of Context

As discussed in Chapter 3, data is collected on the organizational context variables of organization size (i.e, number of employees), environmental uncertainty, and product complexity. Although no specific hypotheses are made regarding these variables, it is expected that these variables should have direct effects on organizational structure as well as moderating effects on the hypothesized relationships between the dimensions of SCM knowledge and the elements of organizational structure. Results of the analyses of the direct effects of the context variables on organizational structure having already been presented, we now proceed with the examination of moderating effects.

In order to test for moderating effects, the sample data is split into two groups at the median for each context variable. For organization size, a median split groups the sample into firms of less than 815 employees and firms of greater than 815 employees. For environmental uncertainty the median is 3.91. Finally, for product complexity, the median is 4.69. Using split samples for each of the context variables, regression analyses are performed and comparisons made between groups. Table 16 provides a comparison of descriptive statistics for all variables used in the split analyses. The results of these analyses are presented in the following sections.

TABLE 16

DESCRIPTIVE STATISTICS FOR ALL VARIABLES IN SPLIT ANALYSES

	Mean Scores	s.d.	Mean Scores	s.d.	t-value
	Small Firms		Large Firms		
Upstream SCM knowledge	4.41	1.13	4.57	1.05	1.08
Internal SCM knowledge	3.94	1.17	4.29	1.02	2.24a
Downstream SCM knowledge	4.26	1.02	4.29	.88	.25
Decentralization	4.19	.71	4.60	.61	4.28a
Performance control	4.95	1.19	5.27	1.08	2.00a
Specialization	7.42	4.34	12.52	3.80	8.77a
Integration	4.15	1.66	4.76	1.34	2.79a
Organization size	5.46	.91	8.18	1.20	18.09a
Environmental uncertainty	3.97	.98	3.79	.91	-1.36
Product complexity	4.33	1.58	4.58	1.44	1.16
	Low Uncertainty		High Uncertainty		
Upstream SCM knowledge	4.54	1.09	4.42	1.11	-.73
Internal SCM knowledge	4.29	1.00	3.96	1.16	-2.17a
Downstream SCM knowledge	4.47	.84	4.07	1.01	-3.12a
Decentralization	4.37	.74	4.42	.64	.52
Performance control	5.21	1.09	5.06	1.18	-.97
Specialization	10.09	4.76	9.83	4.92	-.39
Integration	4.54	1.54	4.31	1.53	-1.08
Organization size	6.93	1.82	6.70	1.65	-.93
Environmental uncertainty	3.07	.55	4.64	.53	20.90a
Product complexity	4.40	1.48	4.54	1.54	.66
	Low Complexity		High Complexity		
Upstream SCM knowledge	4.40	1.05	4.55	1.05	.97
Internal SCM knowledge	3.82	1.07	4.44	1.07	4.24a
Downstream SCM knowledge	4.10	.91	4.44	.90	2.57a
Decentralization	4.33	.74	4.46	.74	1.35
Performance control	4.80	1.09	5.45	1.09	4.28a
Specialization	8.79	4.56	11.13	.25	3.56a
Integration	3.95	1.61	4.86	1.60	4.36a
Organization size	6.54	1.55	7.11	1.58	2.33a
Environmental uncertainty	3.76	.95	3.96	.94	1.46
Product complexity	3.24	1.01	5.72	1.02	21.20a

a $p \leq .05$

Moderating Effects of Organizational Size

The results of the regression analyses testing the effects of organizational size on the hypothesized relationships are displayed in Tables 17 through 20. As illustrated in Table 17, the models predicting decentralization are significant for small firms as well as for large firms.

In the analysis of small firms, none of the estimates of the effects of upstream, internal, or downstream SCM knowledge on decentralization are significant. In the analysis of large firms, only the estimate of the effect of downstream SCM knowledge on decentralization is significant, but the sign of the estimate is opposite (i.e., negative) the expected sign. Thus the finding that downstream SCM knowledge inversely predicts decentralization, reported in the model based upon the full sample, appears to exist only among large firms.

TABLE 17

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND DECENTRALIZATION
FOR SMALL AND LARGE FIRMS

	Variable	Expected Sign	Beta	t	Prob. t
Small Firms					
H1a	Upstream SCM Knowledge	+	.21	1.77	.0800
H1b	Internal SCM Knowledge	+	-.07	-.56	.5760
H1c	Downstream SCM Knowledge	+	-.12	-.93	.3542
	Size		.34	3.42	.0009
	Environmental Uncertainty		-.06	-.51	.6126
	Product Complexity		.22	2.06	.0419
Model F = 3.73 Prob. F = .0024 R^2 = .204 Adjusted R^2 = .150 df = 93					
Large Firms					
H1a	Upstream SCM Knowledge	+	.11	.96	.3380
H1b	Internal SCM Knowledge	+	.06	.55	.5845
H1c	Downstream SCM Knowledge	+	-.34	-2.83	.0057
	Size		.24	2.35	.0208
	Environmental Uncertainty		-.09	-.87	.3848
	Product Complexity		.03	.27	.7912
Model F = 2.44 Prob. F = .0314 R^2 = .141 Adjusted R^2 = .083 df = 95					

Table 18 shows the results of the regression analyses testing the effects of SCM knowledge and context on performance control for small and large firms. The regression models are significant for both small and large firms. Within smaller firms, upstream SCM knowledge and internal SCM knowledge predict performance control. Within larger firms, however, only internal SCM knowledge predicts performance control. The smaller sample size in these models takes its toll as the effect of upstream SCM knowledge does not predict performance control (p=.09) in larger firms. In the full sample model, both upstream and internal SCM knowledge predict performance control. Thus it is concluded that size does not moderate the relationship between SCM knowledge and performance control.

TABLE 18

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND PERFORMANCE CONTROL
FOR SMALL AND LARGE FIRMS

	Variable	Expected Sign	Beta	t	Prob. t
Small Firms					
H2a	Upstream SCM Knowledge	+	.21	2.17	.0328
H2b	Internal SCM Knowledge	+	.34	3.41	.0010
H2c	Downstream SCM Knowledge	+	.11	1.12	.2638
	Size		.11	1.43	.1570
	Environmental Uncertainy		-.14	-1.58	.1184
	Product Complexity		.18	2.12	.0366
Model F = 13.02 Prob. F = .0000	R^2 = .456	Adjusted R^2 = .422			df = 99
Large Firms					
H2a	Upstream SCM Knowledge	+	.17	1.73	.0868
H2b	Internal SCM Knowledge	+	.34	3.66	.0004
H2c	Downstream SCM Knowledge	+	.04	.40	.6909
	Size		.21	2.47	.0155
	Environmental Uncertainty		.03	.41	.6815
	Product Complexity		.22	2.28	.0251
Model F = 9.11 Prob. F = .0000	R^2 = .375	Adjusted R^2 = .334			df = 97

Table 19 shows the results of the regression analyses testing the effects of the dimensions of SCM knowledge and context on specialization for small and large firms. The models for both small and large firms are significant. For small firms, only the estimate of the effect of upstream SCM knowledge on specialization is significant, whereas for large firms, none of the estimates of SCM knowledge are significant. In the full sample model, only upstream SCM knowledge predicts specialization. From these analyses of split samples we see that this relationship holds only for smaller firms, and not for larger firms.

TABLE 19

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND SPECIALIZATION
FOR SMALL AND LARGE FIRMS

	Variable	Expected Sign	Beta	t	Prob. t
Small Firms					
H3a	Upstream SCM Knowledge	+	.30	2.73	.0075
H3b	Internal SCM Knowledge	+	-.04	-.37	.7155
H3c	Downstream SCM Knowledge	+	.07	.63	.5323
	Size		.37	4.06	.0001
	Environmental Uncertainty		-.05	-.50	.6154
	Product Complexity		.18	1.84	.0694
Model F = 6.66 Prob. F = .0000 R^2 = .308 Adjusted R^2 = .262 df = 96					
Large Firms					
H3a	Upstream SCM Knowledge	+	.14	1.35	.1807
H3b	Internal SCM Knowledge	+	.16	1.61	.1099
H3c	Downstream SCM Knowledge	+	-.12	-1.09	.2785
	Size		.38	4.13	.0001
	Environmental Uncertainty		.04	.50	.6153
	Product Complexity		.21	2.01	.0474
Model F = 5.83 Prob. F = .0000 R^2 = .280 Adjusted R^2 = .232 df = 96					

The results of the regression analyses, for small and large firms, testing the effects of SCM knowledge and context on integration are shown in Table 20. The models for both small and large firms are significant. Within smaller firms, both upstream SCM knowledge and internal SCM knowledge predict integration. Within larger firms, only internal SCM knowledge predicts integration. The relatively smaller sample size in these models is evidenced by the nonsignificant (p=.07) estimate of the effect of upstream SCM knowledge on integration. In the full sample model, both upstream SCM knowledge and internal SCM knowledge predict integration. Thus it is concluded that size does not moderate the relationship between SCM knowledge and integration.

TABLE 20

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND INTEGRATION
FOR SMALL AND LARGE FIRMS

	Variable	Expected Sign	Beta	t	Prob. t
Small Firms					
H4a	Upstream SCM Knowledge	+	.25	2.51	.0139
H4b	Internal SCM Knowledge	+	.36	3.32	.0013
H4c	Downstream SCM Knowledge	+	.07	.61	.5438
	Size		.01	.11	.9127
	Environmental Uncertainty		-.03	-.33	.7405
	Product Complexity		.11	1.20	.2339
Model F = 9.53	Prob. F = .0000	R^2 = .383	Adjusted R^2 = .343		df = 98
Large Firms					
H4a	Upstream SCM Knowledge	+	.18	1.82	.0721
H4b	Internal SCM Knowledge	+	.21	2.20	.0302
H4c	Downstream SCM Knowledge	+	.02	.21	.8325
	Size		.27	3.08	.0028
	Environmental Uncertainty		.08	.97	.3367
	Product Complexity		.30	3.05	.0030
Model F = 8.71	Prob. F = .0000	R^2 = .370	Adjusted R^2 = .327		df = 95

Moderating Effects of Environmental Uncertainty

Tables 21 through 24 illustrate the results of the regression analyses testing the effects of SCM knowledge and context variables on the elements of organizational structure for firms operating in environments of low uncertainty and firm operating in environments of high uncertainty.

Specifically, Table 21 shows the results of the analyses testing the effects of SCM knowledge and context variables on decentralization for firms reporting low uncertainty and for firms reporting high uncertainty. Both models being significant, the results further indicate that downstream SCM knowledge is inversely related to decentralization for firms reporting low uncertainty. The smaller sample size appears to take its toll as the effect of downstream SCM knowledge does not predict decentralization for firms reporting high uncertainty ($p=.0577$). For firms reporting low uncertainty, upstream SCM knowledge predicts decentralization, whereas this is not the case for firms reporting high uncertainty. In the full sample model, only downstream SCM knowledge predicts decentralization and the relationship is negative, as is the case in these split sample analyses. Upstream SCM knowledge does not predict decentralization in the full sample model. It is thus concluded that the relationship between upstream SCM knowledge and decentralization exists only for firms reporting low uncertainty. Environmental uncertainty does not appear to moderate the relationship between downstream SCM knowledge and decentralization.

TABLE 21

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND DECENTRALIZATION
FOR LOW AND HIGH ENVIRONMENTAL UNCERTAINTY

	Variable	Expected Sign	Beta	t	Prob. t
Low Uncertainty					
H1a	Upstream SCM Knowledge	+	.25	2.28	.0253
H1b	Internal SCM Knowledge	+	-.03	-.28	.7760
H1c	Downstream SCM Knowledge	+	-.25	-2.39	.0192
	Size		.42	4.21	.0001
	Environmental Uncertainty		-.06	-.66	.5107
	Product Complexity		.13	1.28	.2042
Model F = 5.93	Prob. F = .0000	R^2 = .290	Adjusted R^2 = .241		df = 93
High Uncertainty					
H1a	Upstream SCM Knowledge	+	.10	.86	.3909
H1b	Internal SCM Knowledge	+	.10	.88	.3810
H1c	Downstream SCM Knowledge	+	-.24	-1.92	.0577
	Size		.31	3.15	.0022
	Environmental Uncertainty		-.22	-2.08	.0408
	Product Complexity		.10	.88	.3789
Model F = 3.29	Prob. F = .0057	R^2 = .182	Adjusted R^2 = .126		df = 95

Table 22 shows the results of the regression analyses, for firms reporting low versus high uncertainty, testing the effects of SCM knowledge on performance control. Both the low uncertainty and the high uncertainty regression models are statistically significant. For firms reporting either low or high uncertainty, internal SCM knowledge predicts performance control. However, only for firms reporting high uncertainty does upstream SCM knowledge predict performance control. In the full sample model, both upstream SCM knowledge and internal SCM knowledge predict performance control. Therefore, the finding that upstream SCM knowledge predicts performance control appears to exist only for firms reporting high uncertainty.

TABLE 22

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND PERFORMANCE CONTROL
FOR LOW AND HIGH ENVIRONMENTAL UNCERTAINTY

	Variable	Expected Sign	Beta	t	Prob. t
Low Uncertainty					
H2a	Upstream SCM Knowledge	+	-.05	-.52	.6037
H2b	Internal SCM Knowledge	+	.48	4.58	.0000
H2c	Downstream SCM Knowledge	+	.05	.50	.6167
	Size		.09	.98	.3322
	Environmental Uncertainty		-.06	-.70	.4862
	Product Complexity		.19	1.97	.0515

Model F = 9.16 Prob. F = .0000 R^2 = .376 Adjusted R^2 = .335 df = 97

	Variable	Expected Sign	Beta	t	Prob. t
High Uncertainty					
H2a	Upstream SCM Knowledge	+	.36	4.18	.0001
H2b	Internal SCM Knowledge	+	.30	3.59	.0005
H2c	Downstream SCM Knowledge	+	.08	.87	.3879
	Size		.17	2.40	.0185
	Environmental Uncertainty		-.15	-2.00	.0490
	Product Complexity		.23	2.86	.0052

Model F = 17.55 Prob. F = .0000 R^2 = .531 Adjusted R^2 = .501 df = 99

The results of the regression analyses, for firms reporting low versus high uncertainty, testing the effects of SCM knowledge and context on specialization are shown in Table 23. Both models are significant. The results indicate that the estimate of the effect of upstream SCM knowledge is significant for firms reporting low uncertainty, but not for firms reporting high uncertainty. Here, the relatively small sample size appears to have its effect as evidenced by a nonsignificant ($p=.09$) estimate of the effect of upstream SCM knowledge on specialization for firms reporting high uncertainty. In the full sample model upstream SCM knowledge predicts specialization. Thus it appears that environmental uncertainty does not moderate the relationship between SCM knowledge and specialization.

TABLE 23

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND SPECIALIZATION
FOR LOW AND HIGH ENVIRONMENTAL UNCERTAINTY

	Variable	Expected Sign	Beta	t	Prob. t
Low Uncertainty					
H3a	Upstream SCM Knowledge	+	.20	2.25	.0269
H3b	Internal SCM Knowledge	+	.09	.91	.3657
H3c	Downstream SCM Knowledge	+	-.06	-.72	.4754
	Size		.54	6.61	.0000
	Environmental Uncertainty		-.03	-.43	.6675
	Product Complexity		.14	1.64	.1054
Model F = 13.67 Prob. F = .0000 R^2 = .474			Adjusted R^2 = .439		df = 97
High Uncertainty					
H3a	Upstream SCM Knowledge	+	.16	1.69	.0943
H3b	Internal SCM Knowledge	+	.08	.91	.3649
H3c	Downstream SCM Knowledge	+	.02	.23	.8163
	Size		.63	8.19	.0000
	Environmental Uncertainty		-.00	-.05	.9603
	Product Complexity		.15	1.77	.0802
Model F = 14.71 Prob. F = .0000 R^2 = .498			Adjusted R^2 = .464		df = 95

Table 24 shows the results of the regression analyses testing the effects of SCM knowledge on integration for firms reporting low uncertainty and for firms reporting high uncertainty. In both cases, the regression models are significant. In the full sample model, both upstream SCM knowledge and internal SCM knowledge predict integration. The smaller sample sample size employed in these split sample analyses takes its toll as the effect of upstream SCM knowledge does not predict integration ($p=.10$) for firms reporting low uncertainty. For firms reporting high uncertainty, upstream SCM knowledge does predict integration, and for firms reporting either low or high uncertainty, internal SCM knowledge predicts integration. It is thus concluded that environmental uncertainty does not moderate the relationship between either upstream SCM knowledge or internal SCM knowledge and integration. However, the results also indicate that only for firms reporting high uncertainty, downstream SCM knowledge positively predicts integration. This relationship does not exist either for firms reporting low uncertainty, or in the full sample model. It is thus concluded that environmental uncertainty does moderate the relationship between downstream SCM knowledge and integration, the relationship existing only within firms reporting high uncertainty.

TABLE 24

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND INTEGRATION
FOR LOW AND HIGH ENVIRONMENTAL UNCERTAINTY

	Variable	Expected Sign	Beta	t	Prob. t
Low Uncertainty					
H4a	Upstream SCM Knowledge	+	.17	1.65	.1026
H4b	Internal SCM Knowledge	+	.39	3.60	.0005
H4c	Downstream SCM Knowledge	+	-.14	-1.35	.1788
	Size		.17	1.80	.0751
	Environmental Uncertainty		.05	.58	.5642
	Product Complexity		.13	1.31	.1948
Model F = 7.69	Prob. F = .0000	R^2 = .339	Adjusted R^2 = .295		df = 96
High Uncertainty					
H4a	Upstream SCM Knowledge	+	.20	2.13	.0362
H4b	Internal SCM Knowledge	+	.21	2.32	.0223
H4c	Downstream SCM Knowledge	+	.29	2.84	.0056
	Size		.20	2.57	.0117
	Environmental Uncertainty		.10	1.28	.2027
	Product Complexity		.19	2.18	.0317
Model F = 13.30	Prob. F = .0000	R^2 = .467	Adjusted R^2 = .432		df = 97

Moderating Effects of Product Complexity

The results of the regression analyses testing the effects of SCM knowledge on the elements of organizational structure for firms reporting low product complexity and for firms reporting high product complexity are displayed in Tables 25 through 28.

Table 25 specifically illustrates the results of the regression models testing the effects of SCM knowledge and context on decentralization for firms reporting low versus high product complexity. Both regression models are significant. For firms with low complexity, upstream SCM knowledge (positively) and downstream SCM knowledge (inversely) predict decentralization. For firms with high complexity, none of the dimensions of SCM knowledge predict decentralization. In the full sample model, only downstream SCM knowledge (inversely) predicts decentralization. Based on these split sample analyses, this relationship appears to exist only for firms with low product complexity. Also, a relationship between upstream SCM knowledge and decentralization appears to exist only for firms with low product complexity. Thus product complexity does appear to moderate the relationship between SCM knowledge and decentralization.

TABLE 25

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND DECENTRALIZATION
FOR LOW AND HIGH PRODUCT COMPLEXITY

	Variable	Expected Sign	Beta	t	Prob. t
Low Complexity					
H1a	Upstream SCM Knowledge	+	.22	2.03	.0457
H1b	Internal SCM Knowledge	+	-.03	-.28	.7764
H1c	Downstream SCM Knowledge	+	-.35	-3.33	.0013
	Size		.37	3.89	.0002
	Environmental Uncertainty		-.12	-1.22	.2258
	Product Complexity		.15	1.55	.1250
Model F = 5.72	Prob. F = .0000	R^2 = .280	Adjusted R^2 = .231		df = 94
High Complexity					
H1a	Upstream SCM Knowledge	+	.02	.19	.8466
H1b	Internal SCM Knowledge	+	.05	.41	.6842
H1c	Downstream SCM Knowledge	+	-.06	-.44	.6589
	Size		.40	4.02	.0001
	Environmental Uncertainty		-.01	-.11	.9128
	Product Complexity		.10	.99	.3225
Model F = 3.23	Prob. F = .0065	R^2 = .180	Adjusted R^2 = .125		df = 94

The results of the regression analyses, for firms with low versus high complexity, testing the effects of SCM knowledge and context on performance control are shown in Table 26. The model for low complexity as well as the model for high complexity are significant. The results indicate that internal SCM knowledge predicts performance control for firms with low product complexity as well as for firms with high product complexity. For firms with low product complexity, upstream SCM knowledge also predicts performance control. However, for firms with high product complexity, upstream SCM knowledge does not predict performance control. The results also show that downstream SCM knowledge predicts performance control, but only for firms with high product complexity. In the model of the whole sample, both upstream SCM knowledge and internal SCM knowledge predict performance control. These relationships appear to hold for firms with low product complexity. It is thus concluded that product complexity appears to moderate the relationship between upstream SCM knowledge and performance control, and the relationship between downstream SCM knowledge and performance control.

TABLE 26

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND PERFORMANCE CONTROL
FOR LOW AND HIGH PRODUCT COMPLEXITY

	Variable	Expected Sign	Beta	t	Prob. t
Low Complexity					
H2a	Upstream SCM Knowledge	+	.19	1.99	.0496
H2b	Internal SCM Knowledge	+	.43	4.35	.0000
H2c	Downstream SCM Knowledge	+	.01	.11	.9123
	Size		.03	.31	.7554
	Environmental Uncertainty		-.05	-.53	.5960
	Product Complexity		.12	1.42	.1583
Model F = 9.23	Prob. F = .0000	R^2 = .371	Adjusted R^2 = .330		df = 100
High Complexity					
H2a	Upstream SCM Knowledge	+	.10	.99	.3241
H2b	Internal SCM Knowledge	+	.27	2.79	.0064
H2c	Downstream SCM Knowledge	+	.25	2.15	.0346
	Size		.25	2.92	.0044
	Environmental Uncertainty		-.06	-.64	.5208
	Product Complexity		.12	1.33	.1872
Model F = 9.27	Prob. F = .0000	R^2 = .382	Adjusted R^2 = .341		df = 96

Table 27 shows the results of the regression analyses testing the effects of SCM knowledge and context on specialization for firms with low and high product complexity. The regression models are both significant. For firms with low product complexity, only upstream SCM knowledge predicts specialization. For firms with high product complexity, none of the dimensions of SCM knowledge predict specialization. However, here again the smaller sample size in these models takes its toll as the effect of upstream SCM knowledge in firms with high product complexity (p=07) is not signficant. In the full sample model, upstream SCM knowledge alone predicts specialization. In conclusion, it appears that product complexity does not moderate the relationship between SCM knowledge and specialization.

TABLE 27

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND SPECIALIZATION
FOR LOW AND HIGH PRODUCT COMPLEXITY

	Variable	Expected Sign	Beta	t	Prob. t
Low Complexity					
H3a	Upstream SCM Knowledge	+	.18	2.07	.0412
H3b	Internal SCM Knowledge	+	.17	1.97	.0523
H3c	Downstream SCM Knowledge	+	-.05	-.64	.5207
	Size		.60	7.90	.0000
	Environmental Uncertainty		-.04	-.47	.6417
	Product Complexity		-.03	-.35	.7294
Model F = 16.31 Prob. F = .0000 R^2 = .513 Adjusted R^2 = .481 df = 99					
High Complexity					
H3a	Upstream SCM Knowledge	+	.19	1.82	.0723
H3b	Internal SCM Knowledge	+	-.04	-.36	.7206
H3c	Downstream SCM Knowledge	+	.03	.25	.7998
	Size		.59	6.96	.0000
	Environmental Uncertainty		-.03	-.33	.7388
	Product Complexity		.17	2.03	.0456
Model F = 9.95 Prob. F = .0000 R^2 = .407 Adjusted R^2 = .366 df = 93					

For firms with low versus high product complexity, Table 28 shows results of the regression analyses testing the effects of SCM knowledge on integration. The regression models are both significant. For firms with low product complexity, both upstream and internal SCM knowledge predict integration. However, for firms with high product complexity, it is internal and downstream SCM knowledge that predict integration. In the full sample model, both upsteam and internal SCM knowledge predict integration. The split sample analyses indicate that these relationships hold only for firms with low product complexity. For firms with high product complexity, upstream SCM knowledge no longer predicts integration, and downstream SCM knowledge becomes a predictor of integration.

TABLE 28

MULTIPLE REGRESSION ANALYSIS OF
SCM KNOWLEDGE AND INTEGRATION
FOR LOW AND HIGH PRODUCT COMPLEXITY

	Variable	Expected Sign	Beta	t	Prob. t
Low Complexity					
H4a	Upstream SCM Knowledge	+	.24	2:27	.0258
H4b	Internal SCM Knowledge	+	.29	2.70	.0083
H4c	Downstream SCM Knowledge	+	-.02	-.18	.8562
	Size		.19	2.05	.0434
	Environmental Uncertainty		-.03	-.33	.7400
	Product Complexity		.02	.18	.8543
Model F = 5.84	Prob. F = .0000	R^2 = .276	Adjusted R^2 = .229		df = 98
High Complexity					
H4a	Upstream SCM Knowledge	+	.15	1.42	.1587
H4b	Internal SCM Knowledge	+	.28	2.86	.0053
H4c	Downstream SCM Knowledge	+	.26	2.26	.0263
	Size		.20	2.30	.0237
	Environmental Uncertainty		.03	.37	.7091
	Product Complexity		.11	1.25	.2142
Model F = 8.97	Prob. F = .0000	R^2 = .377	Adjusted R^2 = .335		df = 94

Summary of Research Findings

The empirical results of this study find support for most of the hypothesized relationships between the dimensions of SCM knowledge and the elements of organizational structure. Exploratory analysis of the context variables included in this study provide valuable insight into the conditions under which the hypothesized relationships are supported, as well as providing evidence of the direct effects of these variables on the elements of organizational structure. This provide answers to the study's original research question: Are the dimensions of SCM knowledge related to the dimensions of organizational structure? As hypothesized, there are significant relationships between the dimensions of SCM knowledge and the elements of organizational structure. A fuller discussion of the conditions under which these relationships exist, and explanations of the findings of the analyses are found in the next chapter.

CHAPTER V

DISCUSSION

The discussion of this study is in five parts: (1) an overview of the supporting literature is presented; (2) the research findings are reviewed; (3) the implications for theory and practice are developed; (4) the limitations of the study are investigated; and (5) recommendations for further research are presented.

Overview of Supporting Literature

The major impetus for this study is a recognition of the importance of supply chain management to the success of organizations, and the need to understand supply chain management in terms of organizational knowledge and the effects of this knowledge on organizational structure. Linking the concepts of SCM knowledge and organizational structure provides a basis for:

- investigating the origin of supply chain management knowledge as a value creation process (Von Krogh and Roos 1996) and developing effective measures of its practice

- understanding what forms of organizational arrangements will cope most effectively with the external and internal changes represented by the adoption of SCM practices and knowledge (Lawrence and Lorsch 1967)

- investigating the contexts under which the dimensions of SCM knowledge are most likely to effect organizational form (Hage 1980)

Based on these demands, this study specifically addresses the following research question: Is there a relationship between supply chain management knowledge and organizational structure? To answer this question, the concept of SCM knowledge is developed and its association with organizational structure is examined.

Supply Chain Management Knowledge

The concept of SCM knowledge is developed by synthesizing literatures associated with SCM, JIT, and epistemology. SCM knowledge is defined as the tacit knowledge of an organization evidenced in its performance of SCM related activities. SCM is defined as a mechanism for the coordination of specialists across the supply chain for the maximization of customer value.

Researchers have determined that it is the tacit elements of organizational knowledge that act as "higher order" resources (Hunt and Morgan 1995) and yield competivie advantage (Spender 1996a; Polanyi 1962, 1967). A recent study by Li and Calantone (1998) in a similar area (i.e., market knowledge competence) lends support to the approach taken in this study. Specifically, Li and Calantone identify and examine three separate, yet related, dimensions of market knowledge competence. Similarly, this study identifies and measures three dimensions of SCM knowledge: upstream SCM knowledge, internal SCM knowledge, and downstream SCM knowledge.

SCM knowledge is anchored in the resource-based theory of the firm (Barney 1991; Day 1994b; Hunt and Morgan 1995) and suggests that knowledge is the scarce resource of primary importance to organizations.

Organizational Structure

In order to address the research question of the present study, pertinent elements of organizational structure are identified and measured. The literature related to organizational structure is well established (e.g., Champion 1975; Miller 1991; Mintzberg 1979; Pugh et al. 1968, 1969) and the development of recognized elements of organizational structure is based on numerous studies over an extended period of time. Based on this literature, decentralization, performance control, specialization, and integration surface as the most well-recognized and established elements of organizational structure.

Context Variables

Miller and Dröge (1986) suggest that no study of organizational structure should be conducted.without the inclusion of context variables. Consistent with previous research, the context variables of organization size (e.g., Blau 1970; Child and Mansfield 1972; Kimberly 1976), environmental uncertainty (e.g., Burns and Stalker 1961; Lawrence and Lorsch 1967; Thompson 1967), and product complexity (e.g., Hage 1980; Perrow 1970; Woodward 1965) are most appropriate for inclusion in this study.

Summary of Findings

Investigation of the posited relationships between the dimensions of SCM knowledge and organizational structure rests on the ability to meet four research objectives:

1. The development of measures of the constructs of the dimensions of SCM knowledge (i.e., upstream, internal, and downstream SCM knowledge).

2. The empirical examination of the conceptualized relationships between the dimensions of SCM knowledge and the elements of organizational structure.

3. The investigation of the direct effects of context variables on the elements of organizational structure.

4. The identification of any moderating effects of context variables on the conceptualized relationships between the dimensions of SCM knowledge and the elements of organizational structure.

To accomplish the first objective (the development of measures of the dimensions of SCM knowledge), the following operational definitions of the dimensions of SCM knowledge are developed:

Upstream SCM Knowledge - the tacit knowledge of an organization evidenced in its performance of SCM related activitieswith/from suppliers.

Internal SCM Knowledge - the tacit knowledge of an organization evidenced in its performance of SCM related activites wihin its own organization.

Downstream SCM Knowledge - the tacit knowledge of an organization evidenced in its performance of SCM related activities with/from customers.

Previous research suggests that organizational knowledge manifests itself through organizational actions (Sinkula, Baker, and Noordewier 1997). Each dimension of SCM knowledge is measured using an eight-item scale (3 items are removed from the upstream SCM knowledge scale as part of the scale analysis). The scales are based roughly on one originally developed by Sakakibara et al. (1997) to measure JIT, but modified to reflect SCM practices as well as the three separate dimensions being examined.

Scales designed to measure the elements of organizational structure (i.e., decentralization, performance control, specialization, and integration), and scales to measure the context variables of environmental uncertainty and product complexity are identified from previous research. A questionnaire containing the SCM knowledge scales, the organizational structure scales, the context variable scales, and other questions was sent by facsimile machine to 480 respondents identified from NAPM's (The National Association of Purchasing Management) "Executive List." Of these, 227 were returned, for an effective response rate of 227/480 = 47%.

All scales used in this study are subjected to reliability testing prior to hypotheses testing. With the exception of the SCM knowledge scales, all scales are extensively used in previous marketing or management studies. Support for each of the scales is found. This ensured that the hypotheses tests are not misinterpreted by the use of unreliable or invalid scales.

The second objective of this study is to empirically examine the conceptualized relationships between the dimensions of SCM knowledge and organizational structure. Hypotheses are developed for each of the conceptualized relationships between the dimensions of SCM knowledge (i.e., upstream, internal, and downstream SCM knowledge) and the elements of organizational structure (i.e., decentralization, performance control, specialization, and integration).

Upstream SCM Knowledge

The examination of the relationships between upstream SCM knowledge and decentralization (H1a), performance control (H2a), specialization (H3a), and integration (H4a) yields the following results. Among these four hypotheses, only the estimate of the relationship between upstream SCM knowledge and decentralization is not significant, thus providing strong support for a relationship between upstream SCM knowledge and organizational structure. The lack of support for H1a (upstream SCM knowledge and decentralization) is explained by the overwhelmingly strong relationship between organization size and decentralization, as indicated by the standardized estimate of that relationship (.37). Thus it is argued that size obscures the underlying relationship between upstream SCM knowledge and decentralization.

Internal SCM Knowledge

Analyses of the relationships between internal SCM knowledge and decentralization (H1b), performance control (H2b), specialization (H3b), and integration (H4b) show these results. The estimates of the relationships between internal SCM knowledge and performance control ($p<.01$), and internal SCM knowledge and integration ($p<.01$) are both significant. However, the estimates of the relationships between internal SCM knowledge and decentralization, and between internal SCM knowledge and specialization are not significant. Once, again, the lack of support for relationships is attributed to the strong relationships between organization size and decentralization and between organization size and specialization. In both of these regression models, size is the single strongest predictor. Thus the findings indicate a relationship between internal SCM knowledge and organizational structure.

Downstream SCM Knowledge

Results of the analyses of the relationships between downstream SCM knowledge and decentralization (H1c), performance control (H2c), specialization (H3c), and integration (H4c) are summarized as follows. None of these hypotheses were supported in the analysis of the full sample. However, a significant ($p<.01$), but negative relationship was found between downstream SCM knowledge and decentralization.

There are several factors that contribute to an explanation of these findings. First, it may be argued, particularly in light of the strong relationships between upstream SCM knowledge and organizational structure, that upstream SCM knowledge-based activities are often driven by downstream partners. That being the case, downstream partners, particularly large and powerful customers, may effectively impose operations decisions (e.g., production volumes and schedules) on their upstream suppliers (i.e., the respondent firms in this study). Keeping in mind that the decision-making activities used as measures of decentralization in this study consisted of items that could be usurped by a strong downstream customer (e.g., delivery dates to customers and priorities of orders, transportation scheduling, EDI adoption, production scheduling, etc.), it seems quite reasonable that a negative relationship between downstream SCM knowledge and decentralization might result.

The failure of downstream SCM knowledge to predict either specialization or integration may be explained by the overwhelmingly strong relationships between size and specialization, and between size and integration. Similarly, the extremely strong relationship between internal SCM knowledge and performance control may obscure any relationship between downstream SCM knowledge and performance control.

Size and Organization Structure

Although no hypotheses are proposed concerning the relationships between any of the context variables and the elements of organizational structure, the third objective of this study is to investigate and report these direct relationships.

For organizational size, the analyses indicate a consistent relationship between size and organization structure: decentralization, performance control, specialization, and integration. In fact, in the models predicting both decentralization and specialization, size was the single strongest predictor. It may be concluded that organizational size is the most consistent and strongest predictor of organizational structure.

Environmental Uncertainty and Organization Structure

An examination of the direct effects of environmental uncertainty on the elements of organization structure consistently fails to evidence any relationships. That is, among the estimates of the relationships between environmental uncertainty and the elements of organizational structure (i.e., decentralization, performance control, specialization, and integration) none were significant. Environmental uncertainty does not predict any of the elements of organizational structure in these analyses.

Product Complexity and Organization Structure

Analyses of the direct effects of product complexity on the elements of organization structure show that product complexity predicts performance control, specialization, and integration. Only the estimate of the relationship between product complexity and decentralization is not significant. Here, the strong effect of size on decentralization may obscure any underlying relationship between product complexity and decentalization. Overall, it appears that product complexity consistently predicts organizational structure.

The final purpose of this study was to identify any moderating affects of organizational size, environmental uncertainty, and product complexity on the conceptualized relationships between the dimensions of SCM knowledge and the elements of organizational structure. To this end, additional analyses were performed by splitting the sample according to the medians for each of the context variables. Comparisons of the relationships between the dimensions of SCM knowledge and the elements of organizational structure were made between small and large firms, between firms reporting low and high environmental uncertainty, and between firms reporting low and high product complexity.

Moderating Effects of Size

Organizational size appears to moderate some of the hypothesized relationships between the dimensions of SCM knowledge and organizational structure. Specifically, related to upstream SCM knowledge, the relationship with specialization appears to be moderated by organization size. That is, for large firms, upstream SCM knowledge does not predict specialization, whereas for small firms, as well as for the full sample, upstream SCM knowledge does predict specialization. One apparent explanation for this finding is the strong relationship between size and specialization. In fact, the standardized estimate of the relationship between size and specialization for large firms (.38) is over twice as great as the estimate for any of the dimensions of SCM knowledge. This is not the case within the sample of smaller firms. In other words, large firms are more likely to have greater specialization, merely because of their size. Therefore, within the split sample consisting of larger firms, the degree of specialization may be so high that any relationship between internal SCM knowledge and specialization becomes insignificant.

Analyses of the relationships between internal SCM knowledge and organizational structure for small and large firms provides results consistent with the full sample analysis. Specifically, for both small and large firms, internal SCM knowledge predicts both performance control and integation, but not decentralization or specialization. An explanation of these findings has already been presented in the discussion of the full sample analysis. It is thus concluded that organization size does not moderate the relationships between internal SCM knowledge and organizational structure.

Finally, the relationships between downstream SCM knowledge and organizational structure for small and large firms are examined. A comparison of the results of the analysis of large firms versus the analysis of the full sample model show no differences. That is, for large firms as well as in the full sample analysis downstream SCM knowledge predicts (inversely) only decentralization. However, in the analysis of small firms downstream SCM knowledge fails to predict decentralization or any other element of organizational structure. Therefore, it appears that organization size moderates the relationship between downstream SCM knowledge and decentralization. An explanation for this finding may be found in the significant difference between the mean scores for decentralization between small firms (4.19) and large firms (4.60). That is, the relatively low level of decentralization found in small firms may confound the ability of downstream SCM knowledge to predict decentralization among small firms. models.

Moderating Effects of Environmental Uncertainty

An examination of the relationships between upstream SCM knowledge and the elements of organizational structure for firms reporting low and high uncertainty yields the following results. Uncertainty appears to moderate the relationships between upstream SCM knowledge and decentalization, and between upstream SCM knowledge and performance control. That is, only for firms reporting low uncertainty is upstream SCM knowledge a significant predictor of decentralization. An explanation for this finding lies in the action (i.e., reaction) of firms when faced with high uncertainty to centralize (or rather 'not decentralize') production-related decisions. In other words, upper management in organizations operating in high uncertainty may be more reluctant to push decision-making to lower levels since those decisions may be viewed as more strategic under conditions of high uncertainty than they are under conditions of low uncertainty. This being the case, any relationship between upstream SCM knowledge and decentralization may be diminished within firms reporting high uncertainty.

Among firms reporting low uncertainty, upstream SCM knowledge fails to predict performance control, whereas among firms reporting high uncertainty, as well as in the full sample model upstream SCM knowledge predicts performance control. It is believed that these findings may be the result of a combination of the strong relationship between internal SCM knowledge and performance control and the significantly higher level of internal SCM knowledge found among firms reporting low uncertainty. In other words, for firms reporting low uncertainty, it is believed that the strength of the relationship between internal SCM knowledge and performance control obscures any relationship between upstream SCM knowledge and performance control.

For firms reporting either low or high uncertainty, analyses of the relationships between internal SCM knowledge and the elements of organizational structure yields exactly the same results as the analysis of the full sample. Specifically, for firms reporting either low or high uncertainty internal SCM knowledge predicts both performance control and integation, but not decentralization or specialization. An explanation of these findings has already been presented in the discussion of the full sample analysis. It is concluded that environmental uncertainty does not moderate the relationships between SCM knowledge and organizational structure.

Finally a comparison of the results of the analysis of firms reporting low uncertainty versus results of the analysis of the full sample model show no differences. That is, for firms reporting low uncertainty as well as in the full sample analysis downstream SCM knowledge predicts (inversely) only decentralization. In the analysis of the sample of firms reporting high uncertainty, however, downstream SCM knowledge positively predicts integration. Therefore, it appears that uncertainty moderates the relationship between downstream SCM knowledge and integration. These findings suggest that the hypothesized relationship between downstream SCM knowledge and integration occurs under conditions of uncertainty, but not under conditions of stability (i.e., low uncertainty).

Moderating Effects of Product Complexity

Product complexity appears to be the strongest moderator of the relationships between the dimensions of SCM knowledge and the elements of organizational structure. Related to upstream SCM knowledge, for example, complexity appears to moderate the relationships with decentralization, performance control, and integration. Only the relationship between upstream SCM knowledge and specialization does not appear to be effected by complexity. Specifically, for firms reporting high complexity, upstream SCM knowledge does not predict decentralization. However, for firms reporting low complexity, upstream SCM knowledge does predict decentralization.

The explanation for this finding is complicated by the fact that firms reporting low complexity also report signficantly lower levels of internal SCM knowledge, downstream SCM knowledge, and organization size. Among these differences, it is suggested that the smaller size of firms reporting low complexity is of particular importance given that the strong relationship between size and decentralization. In other words, the relatively small size of firms reporting low complexity provides an explanation for the finding that among firms reporting low complexity upstream SCM knowledge predicts decentralization.

In addition, among firms reporting high complexity, upstream SCM knowledge fails to predict either performance control or integration, whereas among firms reporting low complexity as well as in the full sample analysis upstream SCM knowledge predicts performance control and integration, as well as specializaiton. An explanation applicable to both cases lies in the overwhelmingly strong relationships between internal SCM knowledge and performance control, and between internal SCM knowledge and integration. This argument is further supported by the fact that firms reporting high complexity also report significantly higher levels of internal SCM knowledge. In other words, it is suggested that the extremely strong relationships between internal SCM knowledge and both performance control and integration combine with the significantly higher levels of internal SCM knowledge reported among firms with high complexity, thus obscuring any relationships between upstream SCM knowledge and either performance control or integration.

Results of the analyses of the relationships between internal SCM knowledge and the elements of organizational structure for firms reporting either low or high complexity are consistent with the full sample analysis. Specifically, for firms reporting either low or high complexity internal SCM knowledge predicts both performance control and integation, but not decentralization or specialization. An explanation of these findings has already been presented in the discussion of the full sample analysis. It is thus concluded that product complexity does not moderate the relationships between SCM knowledge and organizational structure. In fact, it can be more generally stated that none of the context variables moderate the relationships between internal SCM knowledge and the elements of organizational structure.

Finally, the relationships between downstream SCM knowledge and organizational structure are examined for firms reporting low and high complexity. A comparison of the results of the analysis of firms reporting low complexity with the analysis of the full sample model show no differences. That is, for firms reporting low complexity, as well as for the full sample, downstream SCM knowledge predicts (inversely) only decentralization. However, in the analyses of firms reporting high complexity, downstream SCM knowledge does not predict decentralization and does predict both performance control and integration.

The obvious explanation for the lack of an inverse relationship between downstream SCM knowledge and decentralization among firms reporting high complexity is found in the strong positive relationship between organization size and decentralization. As has already been noted, firms reporting high complexity are also significantly larger in size than firms reporting low complexity. It is logical to assume that the greater size of firms reporting high complexity, combined with the strong positive relationship between size and decentralization, may effectively negate the inverse relationship between downstream SCM knowledge and decentralization seen in the analysis of firms reporting high complexity.

Finally, among firms reporting high complexity, the findings that downstream SCM knowledge predicts performance control (H2c) and integration (H4c) are consistent with the hypotheses and illustrate a context within which the hypotheses are supported.

Implications

The findings from this study contribute to the field of marketing in both theory and practice. These contributions are discussed in the following sections.

Theoretical Implications

From the theoretical perspective, the present study:

1. Extends the existing research in the areas of supply chain management, organizational knowledge, and organizational structure.
2. Empirically tests conceptual relationships linking SCM knowledge and organizational structure.
3. Examines the direct effects of key context variables on organizational structure.
4. Examines the moderating effects of key context variables on the conceptualized relationships between SCM knoweldge and organizational structure.
5. Integrates organizational knowledge, epistemology, supply chain management and market orientation to advance an internal perspective of marketing management.

Supply chain management has become a topic of great interest to both researchers and practioners, yet very little research relates directly to SCM. By providing both a definition and operationalization of SCM knowledge this study extends existing research in the areas of both organizational knowledge and supply chain management.

Furthermore, it extends research in the organizational structure arena by examining conceptualized relationships between SCM knowledge and organizational structure.

The second theoretical implication relates to the empirical testing of the conceptualized relationships linking SCM knowledge and organizational structure. The development and testing of a conceptual model that includes dimensions of SCM adds to the theoretical foundations of resource-dependency theory (Spender 1996a, 1996b), particularly as it relates to a specific type of organizational knowledge. The conceptual model also adds to the theoretical foundations describing predictors of organizational structure variables.

The inclusion of the context variables of organization size, environmental uncertainty, and product complexity in the conceptual model of SCM knowledge and organization structure provides valuable insight into the direct effects of these variables on the elements of organizational structure. The examination of the moderating effects of these context variables on the conceptualized relationships between the dimensions of SCM knowledge and the elements of organizational structure adds important insight into the conceptualized relationships and the theoretical foundations upon which they are based.

Finally, an internal perspective of marketing management is advanced through the integration of organizational knowledge, epistemology, supply chain management and market orientation. The rich backgrounds of the organizational knowledge and epistemology literatures provide a theoretical foundation for examining the fundamentals of supply chain management. In addition, with its ultimate objective of customer value creation, the development of the supply chain management concept adds to the breadth of the literature and research related to market orientation. This study examines marketing management from a supply chain management perspective.

Managerial Implications

The findings of this study clearly have implications for practioners. First, the operationalization of activities and skills associated with SCM knowledge provides useful information to managers in determining how to create and sustain relatively high SCM knowledge. Prior research demonstrates a number of competitive advantages related to SCM knowledge including profitability (Claycomb, Germain, and Dröge 1999; Edvinsson and Sullivan 1996), reduced system variance (Flynn, Sakakibara and Schroeder 1995), reduced cycle times and system inventories (Handfield and Nichols 1999; Tan, Kannan, and Handfield 1998), and better product design *via* concurrent engineering (Hartley 1992).

Armed with the findings of this study related to what activities and structures facilitate and encourage SCM knowledge, managers can better support and encourage those structures and activities. In addition, the unique insight this study provides into the specific conditions under which the relationships between SCM knowledge and organizational structure best apply allows managers to better plan for changing conditions.

Specifically, it is found that upstream SCM knowledge predicts decentralization, but only under conditions of either low uncertainty or for firms with products of low complexity. Thus managers of firms operating under these conditions may expect, and plan for, increased levels of decentralization as they increase SCM activities with their upstream suppliers. As firms increase their SCM activities with upstream suppliers, managers should also generally expect, and plan for, increased levels of performance control, specialization, and integration. However, increased levels of performance control are less likely to occur in firms operating under conditions of low uncertainty, or with highly complex products. Also, specialization is less likely to increase for large firms who probably already experience high levels of specialization. Finally, integration is less likely to increase for firms with highly complex products.

Further implications for managers include being able to anticipate, and plan for, changes to their organization's structure related to increased internal SCM knowledge (i.e., SCM activities within the firm). Compared to the other dimensions of SCM knowledge, changes to organizational structure related to changes in internal SCM knowledge are relatively simple to predict since those relationships apply under all conditions tested. Specifically, it was found that internal SCM knowledge predicts performance control and integration, but not decentralization or specialization. Again, these findings hold under all conditions tested. With this understanding, managers can anticipate, and plan for, positively related changes to their organization's performance control and integration structures as changes are made in the organization's internal SCM activities.

The relationships between downstream SCM knowledge and organizational structure are perhaps the most difficult to understand, but no less important to organizations, particularly those seeking to increase their SCM knowledge and activities. Contrary to what was expected, it is found that, except for small firms or firms with highly complex products, downstream SCM knowledge inversely predicts decentralization. The explanation put forth for these findings suggests this may be the result of channel power being held by downstream customers. For managers, the implication of these findings is that, as downstream SCM activities increase, there may be pressure to centralize operations decisions. This pressure, however, may be offset by other forces operating within small firms and for firms with complex products.

As firms increase their SCM activities with downstream customers, managers may also expect, and plan for, increased levels of performance control, but only if their products are relatively complex. High product complexity, in fact, is the only condition under which downstream SCM knowledge predicts performance control. Managers may also expect that the level of specialization in their organizations will not change based solely on increases in downstream SCM activities, under any of the contexts investigated in this study. Finally, only managers within firms operating in conditions of high uncertainty or with highly complex products should expect, and plan for, a positive relationship between their downstream SCM activities and integration.

SCM knowledge is generated and retained within an organization as well as within a supply chain. This study provides specific evidence of important relationships between SCM knowledge and organizational structure, particularly related to the structural elements of performance control and integration. The potential benefits to organizations able to increase their SCM knowledge and successfully achieve integration and performance control is only amplified by the complexity of the networks or supply chains in which they operate (Lee and Billington 1992). It is "impossible for us to overestimate," (Senge 1997, p.32) the theoretical or practical implications for management resulting from the creation and sharing of knowledge.

Limitations

The present study has several limitations. First, the use of organizational members as key informants for the organizations. As with many other studies, time and resource constraints dictated the use of the key informant approach to allow a relatively large number of organizations to be surveyed. This may present some problems because managers' insights into cross-functional and interorganizational activities may have been limited. Nonetheless, procurement personnel were arguably the best-suited managers to answer the wide range of questions included in the survey. In addition, the high-level positions held by the informants should help overcome some of the problems associated with this limitation.

Another limitation is the newness of the supply chain management scales. This study represents the first time supply chain management knowledge has been measured as a multi-dimensional construct, and also the first time these scales have been utilized for this particular purpose and in this particular form. Therefore, it is difficult to determine with certainty that the scales truly measure the constructs they were intended to measure (i.e., upstream, internal, and downstream SCM knowledge). The scales do, however, exhibit a high level of reliability. In addition, the traditional scale purification techniques used in the study result in empirical evidence generally consistent with the theory-based relationships upon which the hypotheses are based. Therefore, while some concern over this limitation may be expressed, the analyses also provide strong support for the construct validity of the SCM knowledge scales.

A final limitation is the causal ordering of the variables. Specifically, from a statistical perspective, the assumption in this study regarding the set of dependent and independent variables may be challenged. Although there is precedence and rational justification for the assumptions made in this study, other models may be plausible. For example, it may be that an integrated organizational structure leads to higher levels of SCM knowledge. Results of the regression analyses may have been different if SCM knowledge were modeled as a function of organization structure and context variables. There is even some support in the literature to suggest that strategy may be constrained by structure (e.g., Chandler 1962, 1977). The present study, however, was not designed to examine different causal orderings of the variables. The use of different methodologies (e.g., longitudinal research) or different data analysis techniques (e.g., stepwise regression or path analysis) to explore this issue is left to further research.

Further Research

The present study provides a foundation upon which to make several recommendations for further research. For example, further research could incorporate different measurement as well as analysis methods to investigate the relationships examined in this study. As already mentioned, an investigation of the causal ordering of the variables is in order. Such research would extend the understanding of these relationships beyond mere association and build support for antecedent relationships between the dimensions of SCM knowledge and the elements of organizational structure, or possibly *visa versa.*

The context variables used in the study also deserve further attention. This might include more extensive analysis of the variables used (i.e., organization size, environmental uncertainty, and product complexity) through the use of other analysis techniques that may better illustrate the interaction affects between the context variables. Additional variables may also be considered (e.g., owner-managed organizations, industry type, business unit versus headquarters).

Additional research also might be conducted to further test the validity of the supply chain management scales and to refine the measures. One approach to doing this should be using the scales in other settings besides manufacturing. For example, retail establishments, intermediary distributors, and service providers may all provide interesting areas for studying supply chain management knowledge. Additional testing of the scales will also help establish their validity and help confirm the multiple dimensions of supply chain management knowledge that are developed and presented in this study.

Another avenue for further research is related to the underlying perspective of the present study. As described in Chapter 2, supply chain management knowledge is a type of organizational knowledge. As such, it resides not within any individual, but within an organization and/or within a supply chain. This being the case, further research might utilize other approaches to the measurement of SCM knowledge. For example, multiple informants from different areas of the organization (e.g., purchasing, operations, and marketing) might be used together in order to better measure the cross-functional nature of SCM knowledge. Further, attempts could also be made to measure the interorganizational nature of SCM knowledge by utilizing informants from across established supply chains, rather than within organizations. Such research would present interesting measurement and analysis challenges.

Based on the understanding that SCM activities are basically relational (versus adversarial), further research should incorporate measures of the organization's attitude towards its suppliers and towards its customers (i.e., relational versus adversarial). Any such measures should incorporate the attitude of the respondent as well as the perceived attitude of the organization/upper management. Such information would add to our insight into the true intentions of organizations related to SCM (i.e., lip service versus real change).

In this study, it is suggested that the ultimate objective of SCM is the creation/maximization of customer value. To test this proposition, further research might include various measures of profitability as well as customer value and customer satisfaction. Although measurement of these constructs might prove problematic, further research incorporating such measures could add greatly to our understanding of the benefits of SCM knowledge and the true relationship between SCM knowledge and long-term business performance.

REFERENCES

Achrol, Ravi S. (1991), "Evolution of the Marketing Organization: New Forms for Turbulent Environments," *Journal of Marketing*, 55 (October), 77-93.

Achrol, Ravi S. (1997), "Changes in the Theory of Interorganizational Relations in Marketing: Toward a Network Paradigm," *Journal of the Academy of Marketing Science*, 25 (Winter), 56-71.

Achrol, Ravi S., Torger Reve, and Louis W. Stern (1983), "The Environment of Marketing Channel Dyads: A Framework for Comparative Analysis," *Journal of Marketing*, 47 (Fall), 55-67.

Agarwal, N.C. (1979), "On the Interchangeability of Size Measures," *Academy of Management Journal*, 22 (2), 404-09.

Aiken, Michael and Jerald Hage (1966), "Organizational Alienation: A Comparative Analysis," *American Sociological Review*, 31 (August), 497-507.

Alderson, Wroe (1957), *Marketing Behavior and Executive Action*, Homewood, IL: Irwin.

Aldrich, Howard E. (1972), "Technology and Organization Structure: A Reexamination of the Findings of the Aston Group," *Administrative Science Quarterly*, 17 (1), 26-43.

Aldrich, Howard E. and D. Whetten (1981), "Organization-sets, Action-sets, and Networks: Making the Most of Simplicity," in *Handbook of Organizational Design*, Vol. 1, P. Nystrom and W. Starbuck, eds., New York: Oxford University Press, 385-408.

Alter, Catherine and Jerald Hage (1993), *Organizations Working Together*, Newbury Park, CA: Sage Publications.

Anderson, Erin (1985), "The Salesperson as Outside Agent or Employee: A Transaction Cost Analysis," *Marketing Science*, 4 (Summer), 234-54.

Anderson, Paul F. (1982), "Marketing, Strategic Planning and the Theory of the Firm," *Journal of Marketing*, 46 (Spring), 15-26.

Ansari, A. and B. Modarress (1990), *Just-In-Time Purchasing*, New York: Free Press.

Argyris, Chris and Donald A. Schön (1978), *Organizational Learning: A Theory of Action Perspective*, Reading, MA: Addison-Wesley.

Arrow, K. (1971), *Essays in the Theory of Risk Bearing*, Chicago, IL: Markham.

Arrow, K.J. (1984), "Information and Economic Behavior," in *Collected Papers of Kenneth J. Arrow*, Vol. 4, Cambridge, MA: Belknap Press.

Asaba, Shigeru and Kotaro Kuwada (1989), "The Continuous Side of Discontinuity," *Journal of the Faculty of Economics*. Tokyo Metropolitan University, 63.

Baden-Fuller, C. and M. Pitt (1996). "The Nature of Innovating Strategic Management." in *Strategic Innovation*, C. Baden-Fuller and M. Pitt, eds., London: Routledge, 3-42.

Barnard, C.I. (1938), *The Functions of the Executive*, Cambridge, MA: Harvard University Press.

Barney, Jay B. (1986), "Strategic Factor Markets: Expectations, Luck, and Business Strategy," *Management Science*, 21 (10), 1231-41.

Barney, Jay B. (1991), "Firm Resources and Sustained Competitive Advantage," *Journal of Management*, 17 (1), 99-120.

Bartunek, J.M. (1984), "Changing Interpretive Schemes and Organizational Restructuring: The Example of a Religious Order," *Administrative Science Quarterly*, 29 (September), 355-72.

Bell, Daniel (1973), *The Coming of Post-Industrial Society*, New York: Basic Books.

Beyer, Janice M. and Harrison Trice (1979), "A Reexamination of the Relations Between Size and Various Components of Organizational Complexity," *Administrative Science Quarterly*, 24 (March), 48-64.

Blau, Peter (1956), *Bureaucracy in Modern Society*, New York: Random House.

Blau, Peter M. (1970), "A Formal Theory of Differentiation in Organizations," *American Sociological Review*, 35 (April), 201-18.

Blau, Peter M. and R.A. Schoenherr (1971), *The Structure of Organizations*, New York: Basic Books.

Blau, Peter M. and W. Richard Scott (1962), *Formal Organization*, San Francisco: Chandler Publishing.

Blauner, Robert (1964), *Alienation and Freedom*, Chicago: University of Chicago Press.

Bower, Gordon H. and Ernest R. Hilgard (1981), *Theories of Learning*, Englewood Cliffs, NJ: Prentice-Hall.

Bruner, J.S. and J.M. Anglin (1973), *Beyond the Information Given*, New York: Norton & Co.

Buckley, W. (1967), *Sociology and Modern Systems Theory*, Englewood Cliffs, NJ: Prentice-Hall.

Burns, Tom and G.M. Stalker (1961), *The Management of Innovation*, London: Tavistock.

Caplow, Theodore (1957), "Organizational Size," *Administrative Science Quarterly*, 1 (March), 484-505.

Caplow, Theodore (1965), *Principles of Organization*, New York: Harcourt, Brace and World.

Carter, Joseph R. and Ram Narasimhan (1994), "The Role of Purchasing and Materials Management in Total Quality Management and Customer Satisfaction," *International Journal of Purchasing and Materials Management*, 30 (Summer), 3-14.

Celly, Kirti Sawhney and Gary L. Frazier (1996), "Outcome-Based and Behavior-Based Coordination Efforts in Channel Relationships," *Journal of Marketing Research*, 33 (May), 200-10.

Chakravarthy, B.S. (1982), "Adaptation: A Promising Metaphor for Strategic Management," *Academy of Management Review*, 7 (January), 735-44.

Chamberlin, E.H. (1933), *The Theory of Monopolistic Competition*, Cambridge, MA: Harvard University Press.

Champion, D.J. (1975), *The Sociology of Organizations*, New York: McGraw-Hill.

Chandler, Alfred D. (1962), *Strategy and Structure*, Cambridge: MIT Press.

Chandler, Alfred D. (1977), *The Visible Hand: The Managerial Revolution in American Business*. Cambridge, MA: Harvard University Press.

Chandrashekar, Ashok (1994), "Just-in-Time: A Case Study of the Grind Behind the Glamour," *International Journal of Purchasing and Materials Management*, 30 (Fall), 20-7.

Chapman, Stephen and Phillip L. Carter (1990), "Supplier/Customer Inventory Relationships Under Just In Time," *Decision Sciences*, 21 (Winter), 35-51.

Child, John (1972), "Organizational Structure and Strategies of Control: A Replication of the Aston Study," *Administrative Science Quarterly*, 17 (June), 163-77.

Child, John (1973), "Predicting and Understanding Organization Structure," *Administrative Science Quarterly*, 18 (June), 168-85.

Child, John (1984), *Organization: A Guide to Problems and Practice*, London: Harper & Row.

Child, John and Roger Mansfield (1972), "Technology, Size, and Organization Structure," *Sociology*, 6 (September), 369-93.

Claycomb, Cindy, Richard Germain, and Cornelia Dröge (1999), "Just-in-Time Systems and Performance," *International Journal of Physical Distribution and Logistics Management*, (forthcoming), 1-22.

Coase, R.H. (1937), "The Nature of the Firm," *Economica*, 4, 386-405.

Cohen, Wesley M. and Daniel A. Levinthal (1990), "Absorptive Capacity: A New Perspective on Learning and Innovation," *Administrative Science Quarterly*, 35 (March), 128-52.

Conant, Jeffrey S., Michael P. Mokwa, and P. Rajan Varadarajan (1990), "Strategic Types, Distinctive Marketing Competencies and Organizational Performance: A Multiple Measures-Based Study," *Strategic Management Journal*, 11 (5), 365-83.

Conner, Kathleen (1991), "A Historical Comparison of Resource-Based Theory and Five Schools of Thought Within Industrial-Organization Economics: Do We Have a New Theory of the Firm?" *Journal of Management*, 17 (March), 121-54.

Cravens, David W. and Shannon H. Shipp (1991), "Market-Driven Strategies for Competitive Advantage," *Business Horizons*, 34 (January-February), 53-61.

Cyert, R.M., P. Kumar, and J.R. Williams (1993), "Information, Market Imperfections, and Strategy," *Strategic Management Journal*, 14 (Summer Special Issue), 47-59.

Cyert, Richard M. and James G. March (1963), *A Behavioral Theory of the Firm*, Englewood Cliffs, NJ: Prentice-Hall.

Daft, R.L. (1986), *Organization Theory and Design*, 2nd edition, St. Paul: West Publishing Company.

Dalton, Dan R., William D. Todor, Michael J. Spendolini, Gordon J. Fielding, and Lyman W. Porter (1980), "Organization Structure and Performance: A Critical Review," *Academy of Management Review*, 5 (1), 49-64.

Daniel, S.J. and W.D. Reitsperger (1991), "Management Control Systems for JIT: An Empirical Comparison of Japan and the U.S.," *Journal of International Business Studies*, 22 (4), 603-17.

Davy, Jeanette A., Richard E. White, Nancy J. Merritt, and Karen Gritzmacher (1992), "A Derivation of the Underlying Constructs of Just-In-Time Management Systems," *Academy of Management Journal*, 25 (August), 653-70.

Day, George S. (1994a), "The Capabilities of Market-Driven Organizations," *Journal of Marketing*, 58 (October), 37-52.

Day, George S. (1994b), "Continuous Learning About Markets," *California Management Review*, 36 (Summer), 9-31.

Day, George S. and Robin Wensley (1988), "Assessing Advantage: A Framework for Diagnosing Competitive Superiority," *Journal of Marketing*, 52 (April), 1-20.

Dean, James W. and Scott A. Snell (1991), "Integrating Manufacturing and Jog Design: Moderating Effects of Organizational Inertia," *Academy of Management Journal*, 34 (4), 776-804.

Demsetz, H. (1991), "The Theory of the Firm Revisited," in *The Nature of the Firm*, Williamson and Winter, eds., New York: Oxford University Press, 159-78.

Deshpandé, Rohit (1982), "The Organizational Context of Market Research Use," *Journal of Marketing*, 46 (Fall), 91-101.

Dewar, Robert and Jerald Hage (1978), "Size, Technology, Complexity and Structural Differentiation: Toward a Theoretical Synthesis," *Administrative Science Quarterly*, 23 (March), 111-36.

Dickson, Peter Reid (1992), "Toward a General Theory of Competitive Rationality," *Journal of Marketing*, 56 (January), 69-83.

Dobler, Donald W., Lamar Lee, and David N. Burt (1984), *Purchasing and Materials Management: Text and Cases*, New York: McGraw-Hill.

Drucker, Peter F. (1954), *The Practice of Management*, New York: Harper Brothers.

Drucker, Peter F. (1973), *Management*, New York: Harper & Row.

Drucker, Peter F. (1974), *Management: Tasks, Responsibilities, Practices*, New York: Harper & Row.

Drucker, Peter F. (1985), *Innovation and Entrepreneurship: Practice and Principles*, New York: Harper & Row.

Drucker, Peter F. (1988), "The Coming of the New Organization," *Harvard Business Review*, 66 (January-February), 45-53.

Duncan, Robert G. (1972), "Characteristics of Organizational Environments and Perceived Uncertainty," *Administrative Science Quarterly*, 17 (June), 313-27.

Durkheim, Emile (1933), *The Division of Labor in Society*, George Simpson (translator), New York: Free Press.

Dwyer, F. Robert, Paul H. Schurr, and Sejo Oh (1987), "Developing Buyer-Seller Relationships," *Journal of Marketing*, 51 (April), 11-27.

Edvinsson, Leif and Patrick Sullivan (1996), "Developing a Model for Managing Intellectual Capital," *European Management Journal*, 14 (4), 356-64.

Etgar, Michael (1977), "Channel Environment and Channel Leadership," *Journal of Marketing Research*, 14 (February), 69-76.

Evers, F.T., J.M. Bohlen, and R.D. Warren (1976), "The Relationships of Selected Size and Structure Indicators in Economic Organizations," *Administrative Science Quarterly*, 21 (June), 326-42.

Farmer, David J. (1978), "Developing Purchasing Strategies," *International Journal of Purchasing and Materials Management*, 14 (Fall), 6-11.

Feiwel, George R. (1975), *The Intellectual Capital of Michael Kalecki: A Study in Economic Theory and Policy*, Knoxville: University of Tennessee Press.

Fiol, C.Marlene and Marjorie A. Lyles (1985), "Organizational Learning," *Academy of Management Review*, 10 (October), 803-13.

Flynn, Barbara B, Sadao Sakakibara, and Roger G. Schroeder (1995), "Relationship Between JIT and TQM: Practices and Performance," *Academy of Management Journal*, 38 (5), 1325-60.

Forrester, Jay W. (1958), "Industrial Dynamics," *Harvard Business Review*, 36 (July-August), 37-66.

Fouraker, L.E. and J.M. Stopford (1968), "Organization Structure and the Multinational Strategy," *Administrative Science Quarterly*, 13 (June), 47-64.

Frazier, G.L., R.E. Speckman, and C.R. O'Neal (1988), "Just-in-Time Exchange Relationships in Industrial Markets," *Journal of Marketing*, 52 (4), 52-67.

Fredrickson, James W. (1984), "The Effect of Structure on the Strategic Decision Process," *Academy of Management Proceedings*, 12-16.

Freeland, James R. (1991), "A Study of Just-In-Time Purchasing Practices in the United States," *Production and Inventory Management Journal*, 32 (2nd Quarter), 43-50.

Freeman, John (1973), "Environment, Technology and the Administrative Intensity of Manufacturing Organizations," *American Sociological Review*, 38 (December), 750-63.

Fry, L.W. (1982), "Technology-Structure research: Three Critical Issues," *Academy of Management Journal*, 25 (September), 532-52.

Fuller, S. (1988), *Social Epistemology*, Bloomington, IN: Indiana University Press.

Galbraith, Jay R. (1973), *Designing Complex Organizations*, Reading, MA: Addison-Wesley.

Garvin, David A. (1993), "Building a Learning Organization," *Harvard Business Review*, 71 (July-August), 78-91.

Germain, Richard, and Cornelia Dröge (1997), "An Empirical Study of the Impact of Just-in-Time Task Scope Versus Just-in-Time Workflow Integration on Organizational Design," *Decision Sciences*, 28 (Summer), 615-35.

Germain, Richard, Cornelia Dröge, and Patricia Daugherty (1994), "The Effect of Just-In-Time Selling on Organizational Structure: An Empirical Investigation," *Journal of Marketing Research*, 31 (November), 471-483.

Ghingold, Morry and Bruce Johnson (1997), "Technical Knowledge as Value Added in Business Markets," *Industrial Marketing Management*, 26 (May), 271-80.

Giunipero, Larry C. and Wai K. Law (1990), "Organizational Changes and JIT Implementation," *Production and Inventory Management Journal*, 31 (3rd Quarter), 71-3.

Glazer, Rashi (1991), "Marketing in an Information-Intensive Environment: Strategic Implications of Knowledge as an Asset," *Journal of Marketing*, 55 (October), 1-19.

Goldman, A.I. (1986), *Epistemology and Cognition*, Cambridge, Mass.: Harvard University Press.

Gomes, Roger and John T. Mentzer (1988), "A Systems Approach to the Investigation of Just-In-Time," *Journal of Business Logistics*, 9 (2), 71-88.

Gomes-Casseres, Benjamin (1994), "Group Versus Group: How Alliance Networks Compete," *Harvard Business Review*, 72 (July-August), 62-74.

Graham, Ann B. and Vincent G. Pizzo (1996), "A Question of Balance: Case Studies in Strategic Knowledge Management," *European Management Journal*, 14 (4), 338-346.

Grant, Robert M. (1996a), "Prospering in Dynamically-Competitive Environments: Organizational Capability as Knowledge Integration," *Organization Science*, 7 (July-August), 375-88.

Grant, Robert M. (1996b), "Toward a Knowledge-Based Theory of the Firm," *Strategic Management Journal*, 17 (Winter), 109-22.

Grant, Robert M. and Charles Baden-Fuller (1995), "A Knowledge-based Theory of Inter-Firm Collaboration," *Academy of Management Journal*, Best Papers Proceedings, 17-21.

Grusky, Oscar (1961), "Corporate Size, Bureaucratization, and Managerial Succession," *American Journal of Sociology*, 67 (November), 261-269.

Gustin, Craig M., Patricia J. Daugherty, and Theodore P. Stank (1995), "The Effects of Information Availability on Logistics Integration," *Journal of Business Logistics*, 16 (1), 1-21.

Haeckel, Stephan H. (1990), *Business Strategies in an Information Economy*, report No. 90-119, Cambridge, MA: Marketing Science Institute.

Hage, Jerald (1965), "An Axiomatic Theory of Organizations," *Administrative Science Quarterly*, 10 (December), 289-320.

Hage, Jerald (1980), *Theories of Organizations: Forms, Process, and Transformation*, New York: John Wiley.

Hage, Jerald and Michael Aiken (1970), *Social Change in Complex Organizations*, New York: Random House.

Hair, Joseph F., Rolph E. Anderson, Ronald L. Tatham, and William C. Black (1995), *Multivariate Data Analysis*, Upper Saddle River, NJ: Prentice-Hall.

Hall, Richard H. (1977), *Organizations: Structure and Process*, Englewood Cliffs, NJ: Prentice-Hall.

Hall, Richard H, J. Eugene Haas, and Norman J. Johnson (1967), "Organizational Size, Complexity, and Formalization," *American Sociological Review*, 32 (December), 903-12.

Hambrick, D.C. (1983), "Some Tests of the Effectiveness and Functional Attributes of Miles and Snow's Strategic Types," *Academy of Management Journal*, 26 (March), 5-26.

Handfield, Robert B. and Ernest L. Nichols, Jr. (1999), *Introduction to Supply Chain Management*, Upper Saddle River, NJ: Prentice Hall.

Harrington, Lisa (1995), "Logistics, Agent for Change: Shaping the Integrated Supply Chain," *Transportation and Distribution*, 36 (January), 30-34.

Hartley, J.R. (1992), *Concurrent Engineering*, Cambridge, MA: Productivity Press.

Havens, Charnell and Ellen Knapp (1999), "Easing Into Knowledge Management," Pricewaterhouse Coopers, *http://www.pwcglobal.com*.

Hawley, Amos H., Walter Boland, and Margaret Boland (1965), "Population Size and Administration in Institutions of Higher Education," *American Sociological Review*, 30 (1), 252-55.

Hayek, F.A. (1945), "The Use of Knowledge in Society," *American Economic Review*, 35 (3), 519-30.

Hedberg, B. (1981), "How Organizations Learn and Unlearn?" in *Handbook of Organizational Design*, P.C. Nystrom and W.H. Starbuck, eds., London: Oxford University Press, 8-27.

Hedlund, Gunnar (1994), "A Model of Knowledge Management and the N-Form Corporation," *Strategic Management Journal*, 15 (Summer), 73-90.

Hickson, David J., Derek S. Pugh, and Diana C. Pheysey (1969), "Operations Technology and Organization Structure: An Empirical Reappraisal," *Administrative Science Quarterly*, 14 (September), 378-97.

Hinings, C.R. and Gloria L. Lee (1971), "Dimensions of Organization Structure and Their Context: A Replication," *Sociology*, 5 (1), 83-93.

Hobbs, O. Kermit Jr. (1997), "Managing JIT Toward Maturity," *Production and Inventory Management Journal*, 38 (First Quarter), 47-50.

Houlihan, John B. (1987), "International Supply Chain Management," *International Journal of Physical Distribution and Logistics Management*, 17 (2), 51-66.

Huber, George P. (1984), "The Nature and Design of Post-Industrial Organizations," *Management Science*, 30 (August), 928-51.

Huber, George P. (1991), "Organizational Learning: The Contributing Processes and Literatures," *Organization Science*, 2 (February), 88-115.

Hunt, Shelby D. and Robert M. Morgan (1995), "The Comparative Advantage Theory of Competition," *Journal of Marketing*, 59 (April), 1-15.

Hurley, Robert F. and G. Tomas M. Hult (1998), "Innovation, Market Orientation, and Organizational Learning: An Integration and Empirical Examination," *Journal of Marketing*, 62 (July), 42-54.

Inkpen, Andrew (1998), "Learning Through Alliance: A Framework of Knowledge Acquisition," (working paper).

Inman, R.A. (1990), "Quality Certification for Suppliers by JIT Manufacturing Firms," *Production and Inventory Management Journal*, 31 (2), 58-61.

Jackson, J.H. and C.P. Morgan (1982), *Organization Theory*, 2nd edition, Englewood Cliffs, NJ: Prentice-Hall.

James, Lawrence R., Robert G. Demaree, and Gerrit Wolf (1984), "Estimating Within-Group Interrater Reliability With and Without Response Bias," *Journal of Applied Psychology*, 69 (1), 85-98.

James, Lawrence R., Robert G. Demaree, and Gerrit Wolf (1993), "r_{wg}: An Assessment of Within-Group Interrater Agreement," *Journal of Applied Psychology*, 78 (2), 306-309.

James, W. (1950), *The Principles of Psychology*, Volumes I and II, New York: Dover Publications.

Jarillo, J.C. (1988), "On Strategic Networks," *Strategic Management Journal*, 9 (1), 31-41.

Jauch, Lawrence and Kenneth L. Kraft (1986), "Strategic Management of Uncertainty," *Academy of Management Journal*, 11 (December), 777-90.

Jaworski, Bernard J., Vlasis Stathakopoulos, and H. Shankar Krishnan (1993), "Control Combinations in Marketing: Conceptual Framework and Empirical Evidence," *Journal of Marketing*, 57 (January), 57-69.

Jelinek, M. (1979), *Institutionalizing Innovations: A Study of Organizational Learning Systems*, New York: Praeger.

John, George and John Martin (1984), "Effects of Organizational Structure of Marketing Planning on Credibility and Utilization of Plan Output," *Journal of Marketing Research*, 21 (May), 170-83.

Johnson, Jean L. (1998), "Marketing Perspectives in Knowledge Acquisition and Management: Strategic Issues and Implications," (working paper), Washington State University, 1-35.

Katz, D. and R.L. Kahn (1966), *The Social Psychology of Organizations*, New York: Wiley.

Khandwalla, Pradip N. (1974), "Mass Output Orientation of Operations Technology and Organizational Structure," *Administrative Science Quarterly*, 19 (March), 74-97.

Khandwalla, Pradip N. (1977), *The Design of Organizations*, New York: Harcourt, Brace, Jovanovich.

Kim, Gyu C. and Eiji Takeda (1996), "The JIT Philosophy is the Culture in Japan," *Production and Inventory Management Journal*, 37 (First Quarter), 47-51.

Kimberly, John R. (1976), "Organizational Size and the Structuralist Perspective: A Review, Critique, and Proposal," *Administrative Science Quarterly*, 21 (December), 571-97.

Knight, F.H. (1921), *Risk, Uncertainty and Profit*, Boston, MA: Houghton Mifflin.

Kohli, Ajay K. and Bernard J. Jaworski (1990), "Market Orientation: The Construct, Research Propositions, and Managerial Implications," *Journal of Marketing*, 54 (April), 1-18.

Kuwada, Kotaro (1998), "Strategic Learning: The Continuous Side of Discontinuous Change," *Organization Science*, 9 (November-December), 719-36.

Landes, David S. (1969), *The Unbound Prometheus: Technical Change and Industrial Development in Western Europe from 1750 to Present*, London: Cambridge University Press.

Larson, Paul D. (1994), "An Empirical Study of Inter-Organizational Functional Integration and Total Costs," *Journal of Business Logistics*, 15 (1), 153-69.

Lawrence, P.R. and D. Dyer (1983), *Renewing American Industry*, New York: Free Press.

Lawrence, Paul R. and Jay W. Lorsch (1967), *Organization and Environment: Managing Differentiation and Integration*, Boston: Harvard University.

Lee, Hau L. and Corey Billington (1992), "Managing Supply Chain Inventory: Pitfalls and Opportunities," *Sloan Management Review*, 33 (Spring), 65-73.

Lee, Hau L., V. Padmanabhan, and Seungjin Whang (1997), "The Bullwhip Effect in Supply Chains," *Sloan Management Review*, 38 (Spring), 93-102.

Leenders, Michiel R., Jean Nollet, and Lisa M. Ellram (1994), "Adapting Purchasing to Supply Chain Management," *International Journal of Physical Distribution and Logistics Management*, 24 (1), 40-42.

Lefton, Mark and William R. Rosengran (1966), "Organizations and Clients: Lateral and Longitudinal Dimensions," *American Sociological Review*, 31 (December), 802-10.

Levin, R.C., A.K. Klevorick, R.R. Nelson, and S.G. Winter (1987), "Approaching the Returns from Industrial Research and Development," *Brookings Papers on Economic Activity*, 783-820.

Levine, Sol and Paul E. White (1961), "Exchange as a Conceptual Framework for the Study of Interorganizational Relationships," *Administrative Science Quarterly*, 5 (March), 583-601.

Levitt, B. and J.G. March (1988), "Organizational Learning," in *Annual Review of Sociology* (14), W. Richard Scott and Judith Blake, eds., Palo Alto, CA: Annual Reviews, 319-40.

Li, Tiger, and Roger J. Calantone (1998), "The Impact of Market Knowledge Competence on New Product Advantage: Conceptualization and Empirical Examination," *Journal of Marketing*, 62 (October), 13-29.

Liebeskind, Julia Porter (1996), "Knowledge, Strategy, and the Theory of the Firm," *Strategic Management Journal*, 17 (Winter Special Issue), 93-107.

Lindsay, Peter H. and Donald A. Norman (1977), *Human Information Processing*, Orlando, FL: Academic Press.

Luhmann, Niklas (1987), "The Representation of Society Within Society," *Current Sociological*, 35 (2), 101-8.

Lukas, Bryan A., G. Tomas M. Hult, and O.C. Ferrell (1996), "A Theoretical Perspective of the Antecedents and Consequences of Organizational Learning in Marketing Channels," *Journal of Business Research*, 36 (July), 233-44.

Machlup, F. (1962), *The Production and Distribution of Knowledge in the United States*, Princeton, NJ: Princeton University Press.

Machlup, F. (1980), *Knowledge: Its Creation, Distribution, and Economic Significance*, Volume I, Princeton, NJ: Princeton University Press.

Madhaven, Ravindranath and Grover Rajiv (1998), "From Embedded Knowledge to Embodied Knowledge: New Product Development as Knowledge Management," *Journal of Marketing*, 62 (October), 1-12.

Mansfield, Edwin (1968), *The Economics of Technical Change*, New York: W.W. Norton.

March, James G. and Herbert A. Simon (1958), *Organizations*, New York: John Wiley.

March, James G. (1991), "Exploration and Exploitation in Organizational Learning," *Organization Science*, 2 (1), 71-87.

Marketing Science Institute (1993), *Seeing Differently: Improving the Ability of Organizations to Anticipate and Respond to the Constantly Changing Needs of Customers and Markets*, Report No. 93-103, (May).

Marsh, R.M. and H. Mannari (1981), "Technology and Size as Determinants of the Organizational Structure of Japanese Factories," *Administrative Science Quarterly*, 26 (March), 33-57.

Miles, Robert H. (1982), *Coffin Nails and Corporate Strategies*, Englewood Cliffs, NJ: Prentice-Hall.

Miles, Raymond E. and Charles C. Snow (1978), *Organizational Strategy, Structure, and Process*, New York: McGraw-Hill.

Miles, Raymond E. and Charles C. Snow (1984), "Fit, Failure, and the Hall of Fame," *California Management Review*, 26 (Spring), 10-28.

Miles, Raymond E. and Charles C. Snow (1992), "Causes of Failure in Network Organizations," *California Management Review*, 34 (Summer), 53-72.

Miller, C. Chet, William H. Glick, and George P. Huber (1991), "Understanding Technology-Structure Relationships: Theory Development and Meta-Analytic Theory Testing," *Academy of Management Journal*, 34 (2), 370-99.

Miller, Danny (1983), "The Correlates of Entrepreneurship in Three Types of Firms," *Management Science*, 29 (7), 770-91.

Miller, Danny (1991), "Stale in the Saddle: CEO Tenure and the Match Between Organization and Environment," *Management Science*, 37 (January), 34-52.

Miller, Danny (1996), "A Preliminary Typology of Organizational Learning: Synthesizing the Literature," *Journal of Management*, 22 (3), 485-505.

Miller, Danny and Cornelia Dröge (1986), "Psychological and Traditional Determinants of Structure," *Administrative Science Quarterly*, 31 (December), 539-60.

Miller, D, and P.H. Friesen (1980), "Momentum and Revolution in Organization Adaptation," *Academy of Management Journal*, 23 (December), 591-614.

Miller, D. and P.H. Friesen (1984), *Organizations: A quantum View*, Englewood Cliffs, NJ: Prentice-Hall.

Minahan, Tim (1996), "How Buyers Changed It!", *Purchasing*, 121 (3), 36-38.

Mintzberg, Henry (1979), *The Structuring of Organizations*, Englewood Cliffs, NJ: Prentice-Hall.

Moch, Michael K. (1976), "Structure and Resource Allocation," *Administrative Science Quarterly*, 21 (December), 661-74.

Monczka, Robert M. and Jim Morgan (1998), "Questions You Need to Ask About Your Supply Chain," *Purchasing*, 124 (8), 42-7.

Montague, W.P. (1962), *The Ways of Knowing or the Methods of Philosophy*, 6th impression, London: George Allen & Unwin.

Narver, John C. and Stanley F. Slater (1990), "The Effect of Market Orientation on Business Profitability," *Journal of Marketing*, 54 (4), 20-35.

Natarajan, R. and Donald J. Weinrauch (1990), "JIT and the Marketing Interface," *Production and Inventory Management Journal*, 31 (3rd Quarter), 42-6.

Negandhi, Anant R. (ed.) (1971), *Organizational Theory in an Interorganizational Perspective*, Kent, OH: Kent State University Press.

Negandhi, Anant R. (1975), *Interorganizational Theory*, Kent, OH: Kent State University Press.

Nelson, R.R. and S.G. Winter (1982), *An Evolutionary Theory of Economic Change*, Cambridge, MA: Belknap Press.

Nonaka, Ikujiro (1991), "The Knowledge-Creating Company," *Harvard Business Review*, 69 (November/December), 96-104.

Nonaka, Ikujiro (1994), "A Dynamic Theory of Organizational Knowledge Creation," *Organization Science*, 5 (February), 14-37.

Nonaka, Ikujiro and Hirotaka Takeuchi (1995), *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*, New York: Oxford University Press.

Olson, Eric M., Orville C. Walker, and Robert W. Ruekert (1995), "Organizing for Effective New Product Development: The Moderating Role of Product Innovativeness," *Journal of Marketing*, 59 (January), 48-62.

O'Neal, C.R. (1987), "The Buyer-Seller Linkage in a Just-in-Time Environment," *Journal of Purchasing and Material Management*, 23 (1), 7-13.

Ouchi, W.G. and M.A. Maguire (1975), "Organization Control: Two Functions," *Administrative Science Quarterly*, 20 (December), 550-69.

Parsons, Talcott (1966), *Societies: Evolutionary and Comparative Perspectives*, Englewood Cliffs, N.J.: Prentice-Hall.

Parsons, Talcott and Neil J. Smelser (1956), *Economy and Society*, London.

Patel, Vimla L., David R. Kaufman, Jose F. Arocha, and Sheldon A. Madger (1996), "The Acquisition of Medical Expertise in Complex Dynamic Environments," in *The Road to Excellence: The Acquisition of Expert Performance in the Arts and Sciences*, K. Anders Ericsson, ed., 127-65.

Penrose, E.T. (1959), *The Theory of the Growth of the Firm*, New York: Wiley.

Perrow, Charles (1967), "A Framework for the Comparative Analysis of Organizations," *American Sociological Review*, 32 (April), 194-209.

Perrow, Charles (1970), *Organizational Analysis: A Sociological View*, Belmont, CA: Wadsworth.

Peter, J. Paul (1979), "Reliability: A Review of Psychometric Basics and Recent Marketing Practices," *Journal of Marketing Research*, 16, 6-17, reprinted in *Measurement Readings in Marketing Research*, J. Paul Peter and Michael L. Ray, eds. Chicago, IL: American Marketing Association, 165-76.

Pfeffer, Jeffrey and Gerald R. Salancik (1978), *The External Control of Organizations*, New York: Harper & Row.

Phillips, Lynn W. (1981), "Assessing Measurement Error in Key Informant Reports: A Methodological Note on Organizational Analysis in Marketing," *Journal of Marketing Research*, 18 (November), 395-415.

Pierce, Jon L. and Andre L. Delbecq (1977), "Organization Structure, Individual Attitudes and Innovation," *Academy of Management Review*, 2 (1), 27-37.

Plotkin, H. (1994), *Darwin Machines and the Nature of Knowledge*, Cambridge, MA: Harvard University Press.

Polanyi, M. (1962), *Personal Knowledge: Towards a Post-Critical Philosophy*, corrected edition, Chicago, IL: University of Chicago Press.

Polanyi, M. (1967), *The Tacit Dimension*, Garden City, NY: Anchor Books.

Popper, K.R. (1969), *Conjectures and Refutation: The Growth of Scientific Knowledge*, 3rd edition, London: Routledge & Kegan Paul.

Porac, J.F., H. Thomas, and C. Baden-Fuller (1988), "Competitive Groups as Cognitive Communities: The Case of Scottish Knitwear Manufacturers," paper presented at the *Workshop on Competitive Strategy*, EIASM (November 28), Brussels.

Powell, Walter W. (1990), "Neither Market nor Hierarchy: Network Forms of Organization," in *Research in Organizational Behavior*, L.L. Cummings and B.M. Staw, eds., Greenwich, CT: JAI, 295-336.

Prahalad C.K. and Gary Hamel (1990), "The Core Competence of the Corporation," *Harvard Business Review*, 68 (May/June), 79-91.

Price, James L. (1968), *Organizational Effectiveness: An Inventory of Propositions*, Homewood, Ill.: Irwin.

Pugh, D.S. and D.J. Hickson (1976), *Organizational Structure in its Context: The Aston Programme I*, Westmead, Farnborough, Hants., England: Saxon House/Lexington Book.

Pugh, D.S., D.J. Hickson, D.R. Hinings, K.M. MacDonald, C. Turner, and T. Lupton (1963), "A Conceptual Scheme for Organizational Analysis," *Administrative Science Quarterly*, 8 (December), 289-316.

Pugh, D.S., D.J. Hickson, C.R. Hingings and C. Turner (1968), "Dimensions of Organization Structures," *Administrative Science Quarterly*, 13 (June), 65-105

Pugh, D.S., D.J. Hickson, C.R. Hingings and C. Turner (1969), "The Context of Organization Structures," *Administrative Science Quarterly*, 14 (1), 91-114.

Quinn, Francis J. (1997), "What's the Buzz? Supply Chain Management; Part I," *Logistics Management*, 36 (February), 43-46.

Reimann, Bernard (1973), "On the Dimensions of Bureaucratic Structure: An Empirical Reappraisal," *Administrative Science Quarterly*, 18 (December), 462-76.

Rice, A.K. (1963), *The Enterprise and Its Environment: A System Theory of Management Organization*, London: Tavistock.

Rosen, S. (1991), "Transaction Costs and Internal Labor Markets," in *The Nature of the Firm*, O.E. Williamson and S.G. Winter, eds., New York: Oxford University Press, 75-89.

Rouse, W.H.D. (1984), *Great Dialogues of Plato*, Eric H. Warminton and Philip G. Rouse, eds., New York, NY: Rouse Penguin Books.

Ruekert, Robert W., Orville C. Walker, and Kenneth J. Roering, Jr. (1985), "The Organization of Marketing Actitivities: A Contingency Theory of Structure and Performance," *Journal of Marketing*, 49 (Winter), 13-25.

Rumelt, R.P. (1987), "Theory, Strategy, and Entrepreneurship," in *The Competitive Challenge*, D. Teece, ed., Cambridge, MA: Ballinger, 137-58.

Rumelt, R., D. Schendel, and D.J. Teece (1991), "Strategic Management and Economics," *Strategic Management Journal*, 12 (Winter Special Issue), 5-29.

Sadhwani, Arjan T., M.H. Sarhan, and Dayal Kiringoda (1985), "Just-in-Time: An Inventory System Whose Time Has Come," *Management Accounting*, 67 (December), 36-44.

Sakakibara, Sadao, Barbara B. Flynn, and Roger G. Schroeder (1993), "A Framework and Measurement Instrument for Just-In-Time Manufacturing," Production and Operations Management, 2 (Summer), 177-94.

Sakakibara, Sadao, Barbara B. Flynn, Roger G. Schroeder, and William T. Morris (1997), "The Impact of Just-in-Time Manufacturing and Its Infrastructure on Manufacturing Performance," Management Science, 43 (September), 1246-57.

Sathe, Vijay (1978), "Institutional Versus Questionnaire Measures of Organizational Structure," *Academy of Management Journal*, 21 (2), 227-38.

Scheler, Max (1925), *Die Formen des Wissen und die Bildung*, Bonn: F. Cohen.

Scherer, A.G. and M.J. Dowling (1995), "Toward a Reconciliation of the Theory-Pluralism in Strategic Management," in *Advances in Strategic Management*, (12A), P. Shrivastava and C. Stubbart, eds., Greenwich, CT: JAI Press, 195-247.

Schotter, Andrew (1981), *The Economic Theory of Social Institutions*, New York: Cambridge University Press.

Scott, William R. (1981), *Organizations: Rational, Natural and Open Systems*, Englewood Cliffs, NJ: Prentice-Hall.

Seely-Brown, J. and P. Duguid (1991), "Organizational Learning and Communities of Practice: Toward a Unified View of Working, Learning and Innovation," *Organization Science*, 2 (1), 40-57.

Selto, Frank H., Celia J. Renner, and S. Mark Young (1995), "Assessing the Organizational Fit of a Just-in-Time Manufacturing System: Testing Selection, Interaction and Systems Models of Contingency Theory," *Accounting, Organizations and Society*, 20 (7/8), 665-84.

Selznick, P. (1957), *Leadership in Administration: A Sociological Interpretation*, New York: Harper & Row.

Senge, Peter M. (1990), *The Fifth Discipline: The Art and Practice of the Learning Organization*, New York: Doubleday.

Senge, Peter M. (1997), "Communities of Leaders and Learners," *Harvard Business Review*, 75 (September/October), 30-32.

Shepard, Herbert A. (1967), "Innovation-Resisting and Innovation-Producing Organizations," *Journal of Business*, 40 (June), 470-7.

Shrivastava, P. and I.I. Mitroff (1982), "Frames of Reference Managers Use: A Study in Applied Sociology of Knowledge," in *Advances in Strategic Management*, R. Lamb, ed., Greenwich, CT: JAI Press, 161-82.

Simon, Herbert A. (1957), *Administrative Behavior*, New York: Macmillan.

Simon, Herbert A. (1969), *Strategic Behavior in Business and Government*, Boston: Little, Brown.

Singh, Jitendra (1985), "Technology, Size and Organization Structure: A Reexamination of the Okayama Data," (working paper), Faculty of Management Studies, University of Toronto.

Sinkula, James M. (1994), "Market Information Processing and Organizational Learning," *Journal of Marketing*, 58 (1), 34-45.

Sinkula, James M., William E. Baker and Thomas Noordewier (1997), "A Framework for Market-Based Organizational Learning: Linking Values, Knowledge, and Behavior," *Journal of the Academy of Marketing Science*, 25 (Fall), 305-18.

Slater, Stanley F. (1997), "Developing a Customer Value-Based Theory of the Firm," *Journal of the Academy of Marketing Science*, 25 (Spring), 162-7.

Slater, Stanley F. and John C. Narver (1995), "Market Orientation and the Learning Organization," *Journal of Marketing*, 59 (July), 63-74.

Smith, Ken G., James P. Guthrie, and Ming-Jer Chen (1989), "Strategy, Size, and Performance," *Organizational Studies*, 10 (1), 63-81.

Sorri, M. and J.H. Gill (1989), *A Post-Modern Epistemology: Language, Truth and Body*, Lewiston, NY: E. Mellen Press.

Spender, J.-C. (1989), *Industry Recipes: The Nature and Source of Managerial Judgement*, Oxford: Basil Blackwell.

Spender, J.-C. (1996a), "Making Knowledge the Basis of a Dynamic Theory of the Firm," *Strategic Management Journal*, 17 (Winter Special Issue), 45-62.

Spender, J.-C. (1996b), "Organizational Knowledge, Learning, and Memory: Three Concepts in Search of a Theory," *Journal of Organizational Change*, 9 (1), 63-78.

Stevens, Graham C. (1989), "Integrating the Supply Chain," *International Journal of Physical Distribution & Logistics Management*, 19 (8), 3-8.

Stiglitz, J.E. (1987), "Learning to Learn, Localized Learning and Technological Progress," in *Economic Policy and Technological Performance*, P. Dasgupta and P. Stoneman, eds., Cambridge: Cambridge University Press, 123-53.

Stuart, Ian, Paul Deckert, David McCutcheon, and Richard Kunst (1998), "Case Study: A Leveraged Learning Network," *Sloan Management Review*, 39 (Summer), 81-93.

Stubbart, C.I. (1989), "Managerial Cognition: A Missing Link in Strategic Management Research," *Journal of Management Studies*, 26 (4), 325-47.

Tan, Keah Choon, Vijay R. Kannan, and Robert B. Handfield (1998), "Supply Chain Management: Supplier Performance and Firm Performance," *International Journal of Purchasing and Materials Management*, 34 (Summer), 2-9.

Teece, D.J. (1987), "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing, and Public Policy," in *The Competitive Challenge*, D.J. Teece, ed., Cambridge, MA: Ballinger, 185-219.

Teece, D.J., G. Pisano, and A. Shuen (1990), "Firm Capability, Resources and the Concept of Strategy," (working paper EAP-38), Walter A. Haas School of Business, University of California at Berkeley.

Thompson, D'Arcy (1963), *On Growth and Form*, Volume I, Cambridge, England.

Thompson, James D. (1967), *Organizations in Action*, New York: McGraw-Hill.

Tung, Rosalie L. (1979), "Dimensions of Organizational Environments: An Exploratory Study of Their Impact on Organizational Structure," *Academy of Management Journal*, 22 (December), 672-93.

Van de Ven, Andrew H. (1976), "A Framework for Organizational Assessment," *Academy of Management Review*, 1 (January), 64-78.

Van Twist, M.J.W. and L. Schaap (1991), "Introduction to Autopoiesis Theory and Autopoietic Steering," in, *Autopoiesis and Configuration Theory: New Approaches to Social Steering*, R.J. in't Veld, L. Schaap, C.J.A.M. Termeer, and M.J.W. van Twist, eds., Dordrecht: Kluwer Academic Publishers, 31-44.

Varadarajan, P. Rajan and Margaret H.Cunningham (1995), "Strategic Alliances: A Synthesis of Conceptual Foundations," *Journal of the Academy of Marketing Science*, 23 (Fall), 282-96.

Varela, F.J. (1979), *Principles of Biological Autonomy*, Amsterdam: North-Holland.

Varela, F.J. (1992), "Whence Perceptual Meaning? A Cartography of Current Ideas," in *Understanding Origins: Contemporary Views on the Origin of Life, Mind and Society*, F.J. Varela and J.P. Dupuy, eds., Dordrecht: Kluwer Academic Publishers, 235-64.

Varela, F.J., E. Thompson, and E. Rosch (1992), *The Embodied Mind*, Cambridge, MS: MIT Press.

Vicari, S. (1991), *The Living Firm*, Milano: EtasLibri (in Italian).

Von Hippel, Eric (1988), *The Sources of Innovation*, New York: Oxford University Press.

Von Krogh, Georg and Johan Roos (1995), *Organizational Epistemology*, New York: St. Martin's Press.

Von Krogh, Georg, and Johan Roos (1996), "Five Claims on Knowing," *European Management Journal*, 14 (4), 423-6.

Waley, Arthur (1938), *The Analects of Confucius*, New York, NY: Random House.

Weber, Max (1946), *Essays in Sociology*, H.H. Gerth and C.W. Mills, eds., New York: Oxford University Press.

Webster, Frederick E., Jr. (1992), "The Changing Role of Marketing in the Corporation," *Journal of Marketing*, 56 (October), 1-17.

Wechsler, H. (1992), *Neural Networks for Perception*, Volumes I and II, Boston, Mass.: Academic Press.

Weick, K.E. and K.H. Roberts (1993), "Collective Mind in Organizations: Heedful Interrelating on Flight Decks," *Administrative Science Quarterly*, 38 (September), 357-81.

Weitz, Barton A. and Sandy D. Jap (1995), "Relationship Marketing and Distribution Channels," *Academy of Marketing Science, Journal*, 23 (Fall), 305-19.

Wernerfelt, B. (1984), "A Resource-Based View of the Firm," *Strategic Management Journal*, 5 (2), 171-80.

White, Robert W. (1963), *Ego and Reality in Psychoanalytic Theory: A Proposal Regarding Independent Ego Energies*, New York: International Universities Press.

Williamson, Oliver E. (1975), *Markets and Hierarchies*, Englewood Cliffs, NJ: Prentice-Hall.

Williamson, Oliver E. (1990), "The Firm as a Nexus of Treaties: An Introduction." in.*The Firm as a Nexus of Treaties*, M. Aoki, B. Gustafsson, and O.E. Williamson, eds., Newbury Park, CA: Sage, 1-25.

Winter, Sidney G. (1987), "Knowledge and Competence as Strategic Assets," in *The Competitive Challenge: Strategies for Industrial Innovation and Renewal*, David J. Teece, ed., New York: Harper and Row, 159-84.

Wittgenstein, L. (1958), *The Blue and Brown Books*, London: Blackwell.

Wolfe, A. (1991), "Mind, Self, Society, and Computer: Artificial Intelligence and the Sociology of Mind," *American Journal of Sociology*, 96 (5), 1073-96.

Woodward, Joan (1958), *Management and Technology*, London: Her Majesty's Printing Office.

Woodward, Joan (1965), *Industrial Organization: Theory and Practice*, London: Tavistock.

Workman, John P., Jr. (1993), "Marketing's Limited Role in New Product Development in One Computer Systems Firm," *Journal of Marketing Research*, 30 (November), 405-21.

Yoo, Sangjin (1989), "An Information System for Just-in-Time," *Long Range Planning*, 22 (December), 117-26.

Zaltman, Gerald, Robert Duncan, and Jonny Holbeck (1973), *Innovation and Organizations*, New York: John Wiley.

Zelditch, Morris Jr. and Terrence K. Hopkins (1961), "Laboratory Experiments with Organizaitons," in *Complex Organizations*, Amitai Etzioni, ed., New York: Holt, Rinehart and Winston.

APPENDIX A

SURVEY INSTRUMENT

OSU COLLEGE OF BUSINESS ADMINISTRATION

SURVEY
PROCESS/PRODUCT KNOWLEDGE & ORGANIZATION

---

code: **400-1** **page 1 of 7**
SIC: 37

TO: M ***DATE:***

FAX: ( ) -

FROM: Dr. Richard Germain / OSU

THANKS for agreeing to participate is this important research project.

Please check here ☐, and provide complete mailing instructions in the space below if you wish to receive a summary of research results (we anticipate sending summaries out about November 15, 1998).

Name: ______________________________

Title: ______________________________

Functional Area: ______________________________

Mailing address: ☐ home ☐ business

____

____

____

____

PLEASE RETURN (with this cover) TO:
Dr. Richard Germain, OSU Marketing Department
FAX 405-744-5180
Questions or problems? Call William Christensen, C.P.M., at tel 405-743-1274 or email: chriswj@okstate.edu.

THANK YOU FOR YOUR SUPPORT

A. OPERATING CONTEXT

1. Annual sales .... ________________
2. Number of employees .... ________________

B. STABILITY OF YOUR FIRM'S ENVIRONMENT: Please rate your firm's primary industry:

	Stable environment								Dynamic environment
1.	Sales are ....predictable	1	2	3	4	5	6	7	unpredictable
2.	Market shares are .... stable	1	2	3	4	5	6	7	volatile
3.	Market trends are ....easy to monitor	1	2	3	4	5	6	7	difficult to monitor
4.	Logistics processes change........... slowly	1	2	3	4	5	6	7	rapidly
5.	Industry volume is .... stable	1	2	3	4	5	6	7	volatile
6.	Competitor actions are.......easy to predict	1	2	3	4	5	6	7	difficult to predict
7.	Products become obsolete............slowly	1	2	3	4	5	6	7	quickly
8.	Core production processes change...slowly	1	2	3	4	5	6	7	rapidly
9.	Sales forecasts are likely to be .....accurate	1	2	3	4	5	6	7	inaccurate
10.	New products are introduced...infrequently	1	2	3	4	5	6	7	frequently

C. STRATEGY: Please provide your best estimate in each case.

1. Percent of output subject to statistical quality control .... _____ %
2. Percent of purchase transactions made using EDI .... _____ %
3. Percent of sales transactions made using EDI .... _____ %
4. Percent of manufactured output made to customer order (not made to stock).. _____ %
5. Percent of purchase transactions made on a JIT basis .... _____ %
6. Percent of production made on a JIT basis... _____ %
7. Percent of sales transactions made on a JIT basis .... _____ %
8. Percent of sales spent on product research and development .... _____ %
9. Percent of sales spent on process research and development .... _____ %

D. LONG TERM TRENDS: Please rate your firm concerning each of the following.

	1=Less than five years ago						7=Greater than five years ago
1. The number of suppliers..	1	2	3	4	5	6	7
2. Number of defects per product..	1	2	3	4	5	6	7
3. Number of parts used in production..................................	1	2	3	4	5	6	7

E. KNOWLEDGE may be defined as understanding of some phenomenon. Rate your firm's application (or use) of knowledge in the each of the following areas. We are not asking whether your firm places a high value on knowledge, but whether your firm is currently applying a high level of knowledge.

Internal knowledge application	Application of Knowledge 1=Low						7=High
1. Mechanisms such as statistical process control, Pareto charts, & other analytic tools to improve the quality of processes and products	1	2	3	4	5	6	7
2. "Total Preventive Maintenance" methods	1	2	3	4	5	6	7
3. Demand-pull support systems	1	2	3	4	5	6	7
4. Methods for reducing machine set up times	1	2	3	4	5	6	7
5. Direct labors' understanding of machinery/processes through cross-training....	1	2	3	4	5	6	7
6. Direct labors' understanding of spotting defects/errors in products/processes..	1	2	3	4	5	6	7
7. Cellular plant layout	1	2	3	4	5	6	7
8. Kanban support systems	1	2	3	4	5	6	7
Knowledge applications with/from customers:							
9. Information from customers on their expected product quality levels	1	2	3	4	5	6	7
10. Joint co-design of products with customers	1	2	3	4	5	6	7
11. Information from customers on how they use your goods/component parts....	1	2	3	4	5	6	7
12. Outbound warehouse staging systems proximate to customers to provide them with JIT-type delivery	1	2	3	4	5	6	7
13. Information from customers on their future production plans	1	2	3	4	5	6	7
14. Information from customers that lowers your production costs	1	2	3	4	5	6	7
15. Information from customers that improves outbound delivery and inventory management	1	2	3	4	5	6	7
16. Information from customers that improves your product quality	1	2	3	4	5	6	7
Knowledge applications with/from suppliers:							
17. Information from alternative suppliers on their product quality levels	1	2	3	4	5	6	7
18. Joint co-design of products with suppliers	1	2	3	4	5	6	7
19. Information from suppliers that lowers your production costs	1	2	3	4	5	6	7
20. Information from suppliers that improves inbound delivery and inventory mgmt	1	2	3	4	5	6	7
21. Information from suppliers that improves your product quality	1	2	3	4	5	6	7

Knowledge application by suppliers because of information provided by your firm:	Application of Knowledge 1=Low 7=High
22. Suppliers' application of your firm's production plans (your firm's sharing of production plans with suppliers)	1 2 3 4 5 6 7
23. Suppliers' application of how you use their goods/components in your manufacturing processes	1 2 3 4 5 6 7
24. Warehouse staging systems proximate to your firm that provide you with inbound JIT-type delivery	1 2 3 4 5 6 7

F. PERFORMANCE MEASUREMENT: Rate the extent to which the following control devices are used to gather information about the performance of your firm.

	1=Rarely used						7=Frequently used
1. A comprehensive management control and information system	1	2	3	4	5	6	7
2. Use of cost centers for cost control	1	2	3	4	5	6	7
3. Use of profit centers and profit targets	1	2	3	4	5	6	7
4. Quality control of operations using sampling and other methods	1	2	3	4	5	6	7
5. Formal appraisal of personnel	1	2	3	4	5	6	7

Benchmarking: Rate the extent to which you benchmark (or compare) performance relative to industry standards or industry leaders on:

	1=Rarely used						7=Frequently used
1. Product quality	1	2	3	4	5	6	7
2. Production techniques	1	2	3	4	5	6	7
3. Functional costs (e.g., distribution)	1	2	3	4	5	6	7
4. Overall profitability	1	2	3	4	5	6	7

G. PRODUCTION TECHNOLOGY: Rate the extent to which your organization relies on each of the following technologies.

	Not applicable to principle products						Used almost exclusively
1. Custom technology: production of a single unit or a few units to customer specification	1	2	3	4	5	6	7
2. Small batch (job shop) technology (batches less than one week)	1	2	3	4	5	6	7
3. Large batch technology (e.g., of components for subsequent assembly as in fabricating shops; of finished products such as bottles cans, drugs, chemicals)	1	2	3	4	5	6	7
4. Mass-production technology: as in assembly lines	1	2	3	4	5	6	7
5. Continuous process technology: as in production of liquids, gases or solid shapes (e.g., oil refining)	1	2	3	4	5	6	7

H. PRODUCT COMPLEXITY (KNOWLEDGE IMBEDDED IN PRODUCT): Please rate the complexity of your firm's products.

	Low complexity							High complexity
1.Products are ....non-technical	1	2	3	4	5	6	7	technical
2.Products have ....low engineering content	1	2	3	4	5	6	7	high engineering content
3.Products are ....not very sophisticated	1	2	3	4	5	6	7	very sophisticated
4.Products are ....simple	1	2	3	4	5	6	7	complex
5.Salespeople are..easily trained about products	1	2	3	4	5	6	7	not easily trained about products

I. CONSISTENCY AND AVERAGES: Please rate whether each of the following on: (1) consistency [always the same, very consistent, or low variance]; and (2) average [low, short, or small].

	Consistency: 1=Always the same, very consistent, low variance						7=Rarely the same, very inconsistent, high variance	Average: 1=Average is low/ short/ small						1=Average is high/ long/ large
1. Amount of time for shipments to arrive from key suppliers	1	2	3	4	5	6	7	1	2	3	4	5	6	7
2. Amount of time for shipments to reach key customers	1	2	3	4	5	6	7	1	2	3	4	5	6	7
3. Size of inbound orders	1	2	3	4	5	6	7	1	2	3	4	5	6	7
4. Size of outbound orders	1	2	3	4	5	6	7	1	2	3	4	5	6	7
5. Production lead time (fixed production schedule)	1	2	3	4	5	6	7	1	2	3	4	5	6	7
6. Production lot size	1	2	3	4	5	6	7	1	2	3	4	5	6	7
7. Raw materials/components inventory level	1	2	3	4	5	6	7	1	2	3	4	5	6	7
8. Finished goods inventory levels	1	2	3	4	5	6	7	1	2	3	4	5	6	7
9. In-process inventory levels	1	2	3	4	5	6	7	1	2	3	4	5	6	7
10. Product quality	1	2	3	4	5	6	7	1	2	3	4	5	6	7
11. Individual factory machine speeds	1	2	3	4	5	6	7	1	2	3	4	5	6	7
12. Daily production output rate	1	2	3	4	5	6	7	1	2	3	4	5	6	7
13. Design-to-market cycle time for new product development	1	2	3	4	5	6	7	1	2	3	4	5	6	7

J. INTEGRATION: In assuring the compatibility among decisions in one area (e.g., purchasing) with Those in other areas (e.g., production), to what extent are the following integrative mechanisms used?

	1=Rarely used						7=Frequently used
1. Interdepartmental committees which are set up to allow departments to engage in joint decision-making on an ongoing basis........	1	2	3	4	5	6	7
2. Cross-functional teams which are temporary bodies set up to facilitate interdepartmental collaboration on a specific project.......	1	2	3	4	5	6	7
3. Liaison personnel whose specific job it is to coordinate the efforts of several departments for the purposes of a specific project	1	2	3	4	5	6	7

To what extent is decision making for the following characterized by participative, cross-functional discussions in which management in different departments, functions, or divisions get together:

Cross-functional discussions are......	1=Rarely used						7=Frequently used
1. Distribution / logistics strategy	1	2	3	4	5	6	7
2. Purchasing strategy	1	2	3	4	5	6	7
3. Marketing strategy	1	2	3	4	5	6	7
4. Production strategy	1	2	3	4	5	6	7
5. New product research & development	1	2	3	4	5	6	7
6. New process research & development	1	2	3	4	5	6	7

K. PERFORMANCE: Rate your firm's performance in each of the following areas.	1=Well below industry average						7=Well above industry average
1. Market share growth over the past 3 years	1	2	3	4	5	6	7
2. Sales growth over the past 3 years	1	2	3	4	5	6	7
3. Average return on investment over the past 3 years	1	2	3	4	5	6	7
4. Average profit over the past 3 years	1	2	3	4	5	6	7
5. Profit growth over the past 3 years	1	2	3	4	5	6	7

L. FORMALIZATION: Does your firm possess each of the following written documents?

	Written mission statement?		Written strategic plan?	
	Yes	No	Yes	No
1. Logistics / distribution	[ ]	[ ]	[ ]	[ ]
2. Purchasing	[ ]	[ ]	[ ]	[ ]
3. Production	[ ]	[ ]	[ ]	[ ]
4. Marketing / sales	[ ]	[ ]	[ ]	[ ]
5. Overall Business unit	[ ]	[ ]	[ ]	[ ]

M. SPECIALIZATION: Which of the following activities are dealt with exclusively by at least one full-time person?

	Yes	No		Yes	No
1. Advertising / promotion..........	[ ]	[ ]	10. After sales service..........	[ ]	[ ]
2. Developing / training personnel....	[ ]	[ ]	11. International purchasing....	[ ]	[ ]
3. Production scheduling...............	[ ]	[ ]	12. Market research...............	[ ]	[ ]
4. Sales forecasting......................	[ ]	[ ]	13. Internal quality control......	[ ]	[ ]
5. New process design / research......	[ ]	[ ]	14. Factory location planning...	[ ]	[ ]
6. Warehouse location planning........	[ ]	[ ]	15. Factory layout planning.....	[ ]	[ ]
7. Warehouse layout planning..........	[ ]	[ ]	16. Transportation scheduling..	[ ]	[ ]
8. New product design / research......	[ ]	[ ]	17. Materials handling...........	[ ]	[ ]
9. Inventory planning and control.....	[ ]	[ ]	18. Supplier quality control.....	[ ]	[ ]

N. DECENTRALIZATION: Which level in your firm has authority to make the following decisions?

Select
1 if the level is above the chief executive – this would be the board of directors or owner
2 if the level is the chief executive
3 vice president (or director)
4 if it is a divisional or functional manager such as production or sales manager
5 if it is a sub-department head
6 if it is a first level supervisor
7 if it is made by operatives at the shop level

	1=Above chief executive						7=Operatives at shop level
1. The number of workers required	1	2	3	4	5	6	7
2. Internal labor disputes	1	2	3	4	5	6	7
3. Machinery or equipment to be used	1	2	3	4	5	6	7
4. Allocation of work among available workers	1	2	3	4	5	6	7
5. The types of goods to manufacture	1	2	3	4	5	6	7
6. The volume of production	1	2	3	4	5	6	7
7. Distribution service levels (e.g., fill rates)	1	2	3	4	5	6	7
8. The selection of suppliers	1	2	3	4	5	6	7
9. Product quality levels	1	2	3	4	5	6	7
10. Delivery dates to customers and priorities of orders	1	2	3	4	5	6	7
11. Production scheduling	1	2	3	4	5	6	7
12. Transportation scheduling	1	2	3	4	5	6	7
13. Factory / warehouse location planning	1	2	3	4	5	6	7
14. New product design / research budgeting	1	2	3	4	5	6	7
15. New process design / research budgeting	1	2	3	4	5	6	7
16. EDI adoption decisions	1	2	3	4	5	6	7
17. Inventory planning	1	2	3	4	5	6	7

APPENDIX B

SCALE HISTORY

History of Scales

Survey Scales	Primary Source	Secondary Source
Centralization	**Miller & Droge 1986 - alpha=.82**	**Germain & Droge 1997**
7 point (1=above CE, 7=shop level)	6 point (0=above CE, 5=shop level, or NA	7 point scale (1=above CE, 7=below 1st line superv.)
1. The number of workers required	a) the number of workers required	1. The number of workers required
2. Internal labor disputes	c) internal labor disputes	3. Internal labor disputes
3. Machinery or equipment to be used	j) machinery or equipment to be used	5. Plant machinery or equipment to be used
4. Allocation of work among available workers	k) allocation of work among available workers	2. Allocation of work among available workers
5. The types of goods to manufacture		10. Goods to be manufactured
6. The volume of production		9. Production volume
7. Distribution service levels (e.g., fill rates)		
8. The selection of suppliers		8. Selecting suppliers
9. Product quality levels		
10. Delivery dates to customers and priorities of orders		6. Delivery dates to customers and priority or orders
11. Production scheduling	d) overtime to be worked at shop level	4. Overtime at the plant level
	e) delivery dates and priority of orders	7. Production scheduling
	f) production plans to be worked on	
12. Transportation scheduling		12. The location of factories
13. Factory / warehouse location planning		
14. New product design / research budgeting		
15. New process design / research budgeting	l) method of work to be used	
16. EDI adoption decisions		
17. Inventory planning		
	b) whether to employ a worker	11. The number of factories to operate
	g) dismissal of a worker	
	h) methods of personnel selection	

Survey Scales	Primary Source
Performance Control	**Miller & Droge 1986 - alpha=.78**
7 point (1=rarely used, 7=frequently)	7 point (1=rarely/narrowly used, 7=frequently/broadly)
1. A comprehensive management control and information system	1. A comprehensive management control and information system
2. Use of cost centers for cost control	2. Use of cost centers for cost control
3. Use of profit centers and profit targets	3. Use of profit centers and profit targets
4. Quality control of operations using sampling and other methods	4. Quality control of operations by using sampling and other techniques
5. Formal appraisal of personnel	5. Formal appraisal of personnel

Specialization	**Miller & Droge 1986 - alpha=.80**
check Yes or No box if dealt with full-time	which areas dealt with full-time
1. Advertising / promotion	a) is responsible for PR, advertising, or promotion
2. Developing / training personnel	e) develops and trains personnel
3. Production scheduling	d) acquires and allocates human resources
	j) controls workflow (planning, scheduling)
4. Sales forecasting	
5. New process design / research	l) assesses and devises ways of producing output
	m) devises new outputs, equipment, and processes
6. Warehouse location planning	
7. Warehouse layout planning	
8. New product design / research	
9. Inventory planning and control	g) obtains and controls materials and equipment (buying and stock control)
10. After sales service	b) disposes of, distributes, or services the output
11. International purchasing	
12. Market research	p) acquires information on the market-field of the firm (market research)
13. Internal quality control	k) takes care of quality control (inspection)
14. Factory location planning	
15. Factory layout planning	h) maintains and erects buildings and equipment
16. Transportation scheduling	
17. Materials handling	c) carries outputs, resources, and other material from one place to another
18. Supplier quality control	
	f) takes care of welfare, security, or social services
	i) records and controls financial resources (accounts)
	n) develops and carries out administrative procedures
	o) deals with legal and insurance requirements

Integration	**Miller & Droge 1986 - alpha=.85**
7 point (1=rarely used, 7=frequently)	7 point (1=rarely used, 7=frequently)
1. Interdepartmental committees which are set up to allow departments to engage in joint decision-making on an ongoing basis	1. Interdepartmental committees which are set up to allow departments to engage in joint decision making
2. Cross-functional teams which are temporary bodies set up to facilitate interdepartmental collaboration on a specific project	2. Task forces which are temporary bodies set up to facilitate interdepartmental collaboration on a specific project
3. Liaison personnel whose specific job is to coordinate the efforts of several departments for the purposes of a specific project	3. Liaison personnel whose specific job it is to coordinate the efforts of several departments for purposes of a specific project

Environ. Uncertainty	Celly & Frazier 1996 alpha=.85	Miller & Droge 1986 - alpha=.74
7 point semantic differential scale	5 point semantic differential scale	7 point semantic differential scale
1. Sales are predictable / unpredictable	1. Market is predictable / unpredictable	Demand and consumer tastes are fairly easy to forecast / almost unpredictable
2. Market shares are stable / unstable	2. Stable market shares / volatile ...	
3. Market trends are easy / difficult to monitor	3. Easy to monitor trends / difficult ...	
4. Logistics processes change slowly / rapidly		
5. Industry volume is stable / volatile	4. Stable industry volume / unstable ...	
6. Competitor actions are easy / difficult to predict		Actions of competitors are easy to predict / unpredictable
7. Products become obsolete slowly / quickly		
8. Core production processes change slowly / rapidly		The production/service technology is not subject to very much change and is well established / change often and in a major way
9. Sales forecasts are likely to be accurate / inaccurate	6. Sales forecasts are likely to be accurate / inaccurate ..	
10. New products are introduced infrequently / frequently		The rate are which products/services are getting obsolete in the industry is very slow / high
	5. Certain that selling efforts will pay off / uncertain ...	Our firm must rarely / (frequently) change its marketing practices to keep up with the market and competitors
	7. Sufficient information for marketing decisions / insufficient ...	
	8. Confident of results of marketing actions / unsure	

Product Complexity	Anderson (1985) - coefficient alpha .84
7 point semantic differential scale	7 point semantic differential scale
1. Products are non-technical / technical	1. (Products are) technical / nontechnical (rev.)
2. Products have low / high engineering content	2. (Products are) low / high engineering content
3. Products are / are not very sophisticated	4. (Products are) unsophisticated / sophisticated
4. Products are simple / complex	7. (Products are) complex / simple (rev.)
5. Salespeople are / are not easily trained about products	10. A new salesperson ... in our product class still needs a lot of training (Y/N)
	3. (Products are) fast / slow changing (rev.)
	5. (Products are) commodity / customized
	6. (Products are) unique / common (rev.)
	8. How long would it take for the new salesperson to learn your product line?
	9. What percentage of your dollar volume is of customized products? __%
	11. ...our product line (is viewed) as similar to the competition's (rev.)
	12. It takes very little time for most salespeople to learn our product line (rev.)

Knowledge Application	Sakakibara, Flynn, and Schroeder (1993)
Internal Knowledge	
1. Mechanisms such as statistical process control, pareto charts, & other tools to improve the quality of processes and products	listed as major supporting component
2. Total Preventive Maintenance methods	5 questions related to preventive maintenance
3. Demand-pull support systems	5 questions related to demand-pull system support
4. Methods for reducing machine set up times	4 questions related to set-up time reduction
5. Direct labors' understanding of machinery/processes through cross-training	5 questions related to multifunction workers
6. Direct labors' understanding of spotting defects/errors in products/processes	4 questions related to worker training
7. Cellular plant layout	3 questions related to equipment layout
8. Kanban support systems	4 questions related to Kanban support
Downstream Knowledge	
9. Information from customers on their expected product quality levels	Note: Downstream Knowledge uses the same questions as
10. Joint co-design of products with customers	Upstream Knowledge, but applied to the next level in the supply chain.
11. Information from customers on how they use your goods/component parts	Therefore, the same reasoning that makes the Upstream questions relevant applies to downstream too.
12. Outbound warehouse staging systems proximate to customers to provide them with JIT-type delivery	
13. Information from customers on their future production plans	
14. Information from customers that lowers your production costs	
15. Information from customers that improves outbound delivery and inventory management	
16. Information from customers that improves your product quality	
Upstream Knowledge	
17. Information from alternative suppliers on their product quality levels	inferred in questions related to supplier quality
18. Joint co-design of products with suppliers	Our suppliers are actively involved in our new product development process
19. Information from suppliers that lowers your production costs	inferred in questions related to supplier quality
20. Information from suppliers that improves inbound delivery and inventory management	inferred in questions related to supplier deliveries
21. Information from suppliers that improves your product quality	inferred in questions related to supplier quality
22. Suppliers' application of your firm's production plans (your firm's sharing of production plans with suppliers)	inferred in questions related to supplier deliveries
23. Suppliers' application of how you use their goods/components in your manufacturing processes	inferred in questions related to supplier quality
24. Warehouse staging systems proximate to your firm that provide you with inbound JIT-type delivery	inferred in questions related to supplier deliveries

APPENDIX C

IRB APPROVAL FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD
HUMAN SUBJECTS REVIEW

Date: 05-05-98 **IRB #: BU-98-022**

Proposal Title: PROCESS KNOWLEDGE, PRODUCT KNOWLEDGE, AND ORGANIZATION

Principal Investigator(s): Richard Germain, William Christensen

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

ALL APPROVALS MAY BE SUBJECT TO REVIEW BY FULL INSTITUTIONAL REVIEW BOARD AT NEXT MEETING, AS WELL AS ARE SUBJECT TO MONITORING AT ANY TIME DURING THE APPROVAL PERIOD.
APPROVAL STATUS PERIOD VALID FOR DATA COLLECTION FOR A ONE CALENDAR YEAR PERIOD AFTER WHICH A CONTINUATION OR RENEWAL REQUEST IS REQUIRED TO BE SUBMITTED FOR BOARD APPROVAL.
ANY MODIFICATIONS TO APPROVED PROJECT MUST ALSO BE SUBMITTED FOR APPROVAL.

Comments, Modifications/Conditions for Approval or Disapproval are as follows:
This is exempt in that the survey doesn't appear to request any sensitive information even though the identity of the corporation and individual respondents can be "back-traced" through the FAX numbers that will be printed on the returned surveys. It is suggested that this be cut off from each page. The argument against including an informed consent form is unconvincing and displays a poor understanding of the purpose of an informed consent document. Since this survey falls within an EXEMPT category, an informed consent form is unnecessary.

Signature: John H. Wyckoff

Chair of Institutional Review Board

Date: May 5, 1998

cc: William Christensen

1

VITA

William James Christensen

Candidate for the Degree of

Doctor of Philosophy

Thesis: SUPPLY CHAIN MANAGEMENT KNOWLEDGE AND ORGANIZATIONAL STRUCTURE

Major Field: Business Administration

Biographical:

Education: Graduated from Tempe Union High School, Tempe, Arizona, in May 1973; received Bachelor of Arts degree in East Asian Studies and a Masters degree in Business Administration Management from California State University, Hayward, California, in March 1978 and March 1981, respectively. Completed the requirements for the Doctor of Philosophy degree with a major in Business Administration at Oklahoma State University, Stillwater, Oklahoma, in May 2000.

Experience: Employed by Morrison-Knudsen Company, Idaho Fall, Idaho, as a Subcontract Administrator, and in Burlingame, California, as a Purchasing Agent, 1981 to 1984; employed by Whirlpool Corporation as an International Buyer, Benton Harbor, Michigan, 1984 to 1989; employed by Western Steel as Vice-President and President, Holt, Michigan, 1988 to 1993; employed by Clark Material Handling Company as Director of Procurement, Lexington, Kentucky, 1994 to 1995; employed by Mercury Marine as Purchasing Director, Stillwater, Oklahoma, 1995 to 1996; employed by Bombardier-Learjet as Purchasing Consultant, Wichita, Kansas, 1997 to 2000; employed by Michigan State University as Instructor, East Lansing, Michigan, 1989 to 1993; employed by Oklahoma State University as Instructor, Stillwater, Oklahoma, 1997 to 1999.

Professional Memberships: National Association of Purchasing Management, APICS, American Marketing Association.