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AN ENTERPRISE MODEL OF MASS CUSTOMIZATION WITHIN THE TEXTILE INDUSTRY

by

KEVIN J. O'MARA

A dissertation submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the Doctorate Degree

DEPARTMENT OF TEXTILE AND APPAREL MANAGEMENT

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ABSTRACT

O'MARA, KEVIN JOHN. An Enterprise Model of Mass Customization Within the Textile Industry. (Under the direction of Dr. Samuel C. Winchester.)

A new business paradigm is emerging called "Mass Customization". This apparent oxymoron offers firms the prospect of providing high quality, low price products or services that are also customized to each individual customer.

The primary purpose of the research undertaken for this dissertation was to develop a model of Mass Customization that incorporated and integrated concepts from operations management, marketing, strategic management, accounting, and information technology. A model was developed and submitted for review to the acknowledged experts in the field today. A revised model incorporating their feedback and comments was designed.

A secondary purpose of the project was to determine the current perception of Mass Customization by representatives from the textile industry. Their perceptions were gathered using a structured questionnaire that was personally administered by the researcher in over 80% of the cases. Hypotheses ranging from the influence of functional background to the impact of industry position were tested. All five hypotheses were supported.

DEDICATION

This is the easiest decision that I have had to make in this whole process. My dissertation is completely and entirely dedicated to my family comprised of my wife, Cheri, and my children, Emily and Timmy. They have made the most personal of all sacrifices - time.

Over the past dozen years, Cheri has had to live with frustrations, anguish, disappointments, and uncertainties over which she has had little or no control. While the shortcomings and failures have been of my making, she has equally felt the unfortunate fallout. Without fail and without exception, Cheri has always shown remarkable support and encouragement. During a period of almost endless uncertainty, her support for whatever I decided to pursue has been the one constant that I could always count upon.

The last four years have been especially difficult for Cheri. I have had to spend so much time in my office at night that she has often been left alone to care for our little girl, Emily, and our newborn son, Timmy. As trying as the program at NCSU was, I am sure Cheri had the more trying experience. Without a doubt this degree is just as much Cheri's as it is mine. While we can never replace the time lost over the past years, we can devote ourselves to making the most of the rest of our lives. I am committed to achieving this mission together with my wonderful wife.

I would also like to dedicate this dissertation to Emily and Timmy. I cannot think of Emily without smiling - smiling from laughter, smiling from memories, and smiling with pride. I have truly missed the evenings and weekends we spent together

prior to the NCSU program. The thought of returning to those happy times often got me through difficulties, tiredness, and writer's block. Emily is such a special girl. I don't want to miss or hurry through anymore of her life.

Finally, I dedicate this dissertation to my boy, Timmy. A kinder, sweeter little boy cannot be found. My biggest regret of this program is missing out on so much of his early childhood. The regret is only compounded by the difficulties he went through during these past 4 years (shouldered primarily by my wife). I had a solid base of a relationship with Emily when I started this program but not with Timmy. He was too young. Time lost is time lost but I pledge to redouble my efforts and build a solid foundation for our future lives together.

I have never been an advocate for the distinction between quality time and quantity of time. Families just need time together. Hopefully, the end of this dissertation signals the beginning of a new time where time, both quality and quantity, is available for those I love the most.

BIOGRAPHY

Kevin J. O'Mara is currently an Assistant Professor in the Love School of Business at Elon College. He resides in the town of Elon College with his wife, Cheri, and two children, Emily (age 6) and Timmy (age 3). Prior to moving to North Carolina to pursue a doctorate, Kevin was employed in the oil industry in Houston, Texas. His responsibilities ranged from economic analysis to operations and divisional planning. While in Houston, Kevin received his MBA with a concentration in accounting from the University of Houston. Soon after finishing the program, he passed the examination to become a Certified Management Accountant (CMA).

Kevin attended the University of Texas at Austin for his undergraduate degree. While at Texas, he pursued a dual route of Engineering and Business. He arrived at college fresh from his graduation from Port Allegany High School in a small northwest Pennsylvania town that bears the same name.

ACKNOWLEDGMENTS

There are many people who have helped me complete this dissertation for whom I would like to express my gratitude. I have received enormous support and constant encouragement from my colleagues at Elon College, especially Ms. Deborah Caldwell and Dr. Sheila Hall. My deans, Dr. Robert Guffey, Mr. Richard Behrman, and Dr. John Burbridge along with my chairman, Dr. Wonhi Synn and my Provost, Dr. Gerald Francis, have done everything they could to enable me to complete this degree. Without their efforts, I would not have been able to structure a schedule conducive to attending NCSU.

I owe a special thanks to Dr. Andrew Boynton for his knowledge of Mass Customization, his contacts, and, equally importantly, his moral support. Mr. Joseph Pine was particularly gracious with his time on my behalf. Reaching back into my childhood for assistance from Dr. Kevin Eastman and Mr. (soon to be Dr.) Alan Eastman proved invaluable for the millionth time. Once again, I was impressed with their intellect while enjoying their humor. My knowledge of survey research owes a debt of thanks to Dr. Jackie Eastman. I would also like to acknowledge the efforts of Mr. Chuck Bass during the SAS phase of my paper. Mr. Coleman Rich was a constant source of industry knowledge and ideas throughout the time I spent at NCSU. Finally, Ms. Sally and Mr. Ron Klepcyk were invaluable throughout this entire process in ways that only close friends can be. Better neighbors do not exist. While all the above individuals contributed in tangible ways to this project, it was the comfort that I had access to their expertise

(whether I called or not) that often carried me through difficult stages of the process. Thank you.

I would like to thank the faculty at NCSU for allowing me to participate in their excellent program. Dr. Gary Smith, Dr. George Hodge, Dr. Perry Grady and Dr. William Oxenham were more than patient with me as I journeyed into the nuances of textile technology. Each was an excellent teacher and even a nicer person.

Finally, I cannot thank Dr. Sam Winchester enough for all that he has done for me over the past few years. When I first met with Dr. Winchester, he was the last hope in my quest to receive the doctorate I needed to continue in my chosen profession. He more than turned my hope into salvation, he turned me around. Given the circumstances under which we met and the ultimate impact that Dr. Winchester had on me, I am today a much stronger believer in fate than I was four years ago. I truly feel blessed to have met and gotten to know Dr. Winchester. It has been a privilege to work with such an special individual. I have often remarked to colleagues and friends that I have never met a person that possesses his rare combination of superior intellect, curiosity, business acumen, sense of humor, and kindness. If the true measure of a person's life is the amount of impact one has on the lives of others then Dr. Winchester can sit back, relax, and rest assured that he made a tremendous difference in my life. I am forever grateful.

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GLOSSARY OF ABBREVIATED TERMS

ABC	Activity Based Costing
ANOVA	Analysis of Variance
CIM	Computer Integrated Manufacturing
CPI	Continuous Process Improvement paradigm
DFM	Design For Manufacture
EDI	Electronic Data Interchange
EOQ	Economic Order Quantity
ERP	Enterprise Resource Planning
GOC	Graphical Order Configurator
IO	Industrial Organization economic
IT	Information Technology
JIT	Just-in-Time inventory
MIS	Management Information Systems
MRP	Material Resource Planning
NPV	Net Present Value
SAD	Sales Aided Device
SBU	Strategic Business Unit
TQM	Total Quality Management

CHAPTER ONE:
INTRODUCTION

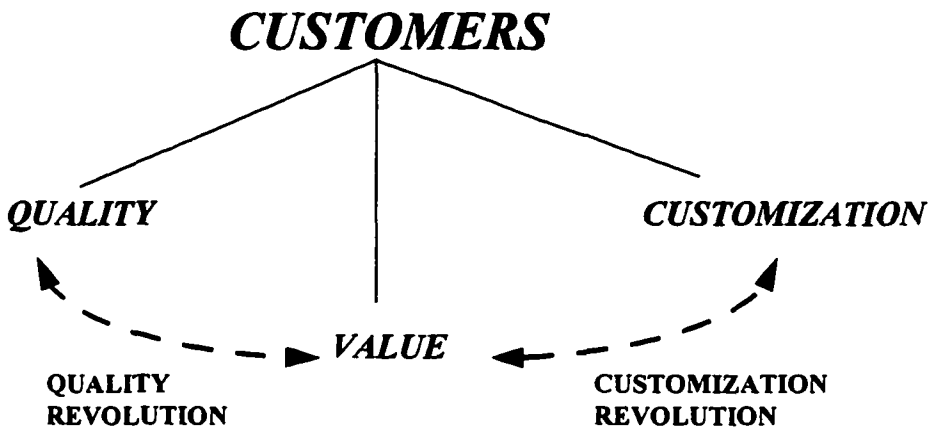
The competitive environment within the textile industry over the past few of decades has not been kind to many firms. Significant changes in competition, technology and customer demands have altered the competitive landscape. Competition has arisen from all corners of the globe and many of these new competitors arrive with substantial cost advantages due to lower wage rates. Technological advances changing operating machinery, communication vehicles, and information exchanges threaten many firms while opening up opportunities for others. Consolidation in many industry segments and new global producers give customers additional power to demand better price/quality characteristics while being more selective with their business. The upshot from all of these developments is that uncertainty within the industry is rising and profit margins are tightening. Firms within the textile industry today face many strategic choices in this era of unprecedented change. Applying Darwin's Theory of Natural Selection as a metaphor, those firms that cannot adapt to this new competitive environment will be "selected out" of the industry while many of those that will survive will have to undergo a metamorphosis to carve out their competitive niche (Hannah and Freeman, 1977).

As companies search for sustainable strategies for surviving and thriving within the global textile complex, a new form of competition called "Mass Customization" has received much attention. The term, first coined by Stan Davis

(1987), has come to mean developing the ability to customize products for each customer at prices similar to those manufactured by Mass Production methods (Pine, 1993a). While it has been successfully implemented in some industries, most notably personal computers, it is just now being introduced to many industries, including textiles. Levi Strauss has perhaps the highest profile in the textile industry using Mass Customization with their "Personal Pair" Jeans line which purports to custom fit jeans for each customer for only a 10% surcharge (Rifkin, 1994).

While Mass Customization is certainly in its infancy, many experts feel that the capability to offer customized features for today's demanding customers may enable firms possessing this ability to tilt the competitive playing field in their favor. Mass Customization is being viewed as more than a new production process. It is being hailed as a new business paradigm that can be used as a cornerstone for a new strategic approach. As with those whom first adopted previous paradigms of Mass Production and Quality, it is argued that significant "first-mover advantages" (Lieberman and Montgomery, 1988) will accrue to the early successful adopters of the Mass Customization paradigm.

FIGURE 1
GENERIC CUSTOMER NEEDS



Customers desire a high quality product at a low price that meets their own particular needs

Figure 1 depicts generic customer needs that have not changed over time. Customers want a quality product at a low price that is customized to their needs. Historically, it has been assumed that all three dimensions of customer needs could not be met simultaneously (Hart and Taylor, 1996). It was thought that customers must make trade-offs along the dimensions since increasing quality and increasing customization were considered directly related to increasing costs. However, this entrenched mindset was challenged by the Quality Revolution of the 1980s advocated by gurus such as Deming (1982), Juran (1979), and Crosby (1979). As Crosby put it, "Quality is free", meaning that a direct relationship does not have to exist between quality levels and costs. Many textile firms have found that to be true and dismissed the notion that a trade-off between quality and cost must exist.

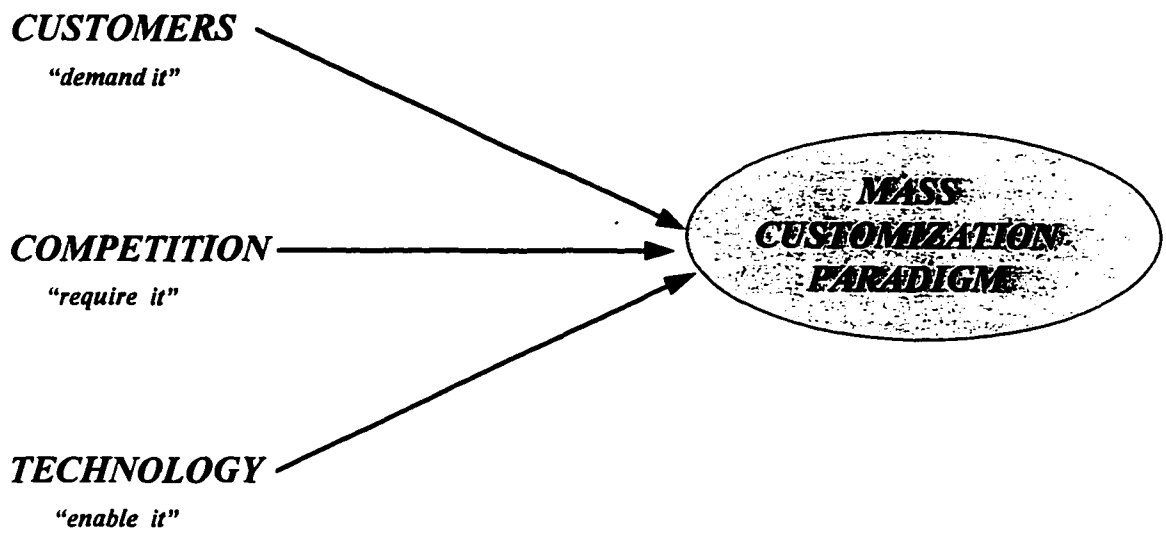
Proponents of Mass Customization believe the other long-held assumption that customization must raise costs can now be challenged as well. While the Quality Revolution was driven by focusing on changing management systems, techniques, and attitudes, the Customization Revolution is propelled more by technology. Communication, information, and machine technologies are the backbone of Mass Customization. Without these technologies providing the coordination mechanisms, it would be difficult, if not impossible, to consider customization on a mass scale.

Mass Customization is being driven by the same three powerful forces that drive most paradigm transitions in business -- Customers, Competition, and Technology (Figure 2). Customers have become more powerful because they now have the ability to choose among multiple worldwide suppliers. This is the classic situation Porter (1980) termed, "buyer power" in his seminal book on competitive strategy. Customers are beginning to flex their new found power by demanding customization along with their previous requirements of high quality and value pricing.

Given the global nature of business today, many firms are reevaluating their strategies. The minimum ante to compete in many industries is rapidly rising. Many are concluding that the opportunities to differentiate on the grounds of costs or quality are limited and are searching for new sources of competitive advantages that will be required to compete in the future.

Finally, technological advances, along with their rapidly declining cost, have opened up new approaches for businesses that were merely pipedreams until very recently. Technology is often the initiator and enabler of new opportunities and paradigms.

FIGURE 2
FORCES DRIVING MASS CUSTOMIZATION



1.1 PURPOSE OF RESEARCH PAPER

The primary purpose of the proposed research is to focus on the new phenomenon called Mass Customization and attempt to begin the process of understanding how it can be implemented. A model is developed that attempts to capture the major elements and their arrangement for implementing Mass

Customization at the "enterprise" level. This model will be validated by experts within the field and knowledgeable individuals within the textile industry.

A secondary purpose of this research is to develop an understanding of how the textile industry perceives Mass Customization and where the industry feels that Mass Customization will likely be introduced and by what type of company. A survey of industry participants will be used to gather data on these issues specific to the textile industry.

1.2 CONTRIBUTION OF PROPOSED RESEARCH

The contributions to the field of organizational research by this proposed research can be captured in two categories: Relevancy and Research Stream Development.

Mass Customization is a new paradigm that may offer significant opportunities for those textile firms that can marry the necessary operational capabilities with a market opportunity. Given the intense competitive environment that currently characterizes the textile industry, a new approach that offers competitive advantages is certainly relevant to today's business leaders. The fact that firms in other industries (albeit few at this point) have adopted Mass Customization and have garnered financial and competitive advantages from its implementation indicates that Mass Customization is far more than a conceptual notion. It is relevant to managers today. Firms within the textile industry that understand how to best incorporate Mass

Customization within their business strategy may find an elusive, sustainable competitive advantage. Anytime a research study can aid business in understanding a new technique or approach it scores high on the relevancy index.

The second major contribution of the proposed research centers on the newness of the concept. Mass Customization is an exciting new field spawning an emerging literature. What is known about Mass Customization has come from anecdotal evidence of adopting firms (Randall, 1993b; Henricks and Hasty, 1995), conceptual articles discussing how this paradigm differs from past paradigms (Davis, 1989; Pine, 1993b Pine, Victor, and Boynton, 1993; Boynton and Victor; 1991), and research focusing on the enabling components or functions (Goldman, Nagel, and Preiss, 1995; Pepper and Rogers, 1993; Kotha, 1994). While these works have certainly contributed extensively to an understanding of Mass Customization, this new paradigm has not been adequately modeled at an enterprise level. Prior efforts have focused on parts of the model but a full model integrating the component elements has not been published to date. It is hoped that a theoretical model integrating multiple organizational disciplines will initiate a stream of research on its various facets. This stream of research will ultimately culminate in a refined model that can aid managers in their implementation efforts.

Bettis (1991) observed that management research is often driven by multivariate statistical methodology using outdated concepts that result in findings and theories that are irrelevant and impractical to practicing managers. This view is

increasingly being shared by others in the field (Daft and Lewin, 1990; Mintzberg, 1994). To correct this shortcoming, Bettis challenged management researchers to look at emerging issues by employing more unstructured and exploratory research that look beyond statistical averages to those outliers that are the precursors of change. He proposed a need for more "problem-driven" research as opposed to "theory-driven" research as,

> "Problem-driven research can induce new theory and validate, reject, or extend existing theories in ways that 'theory-driven' research cannot. It is not an either/or question but a question of balance." (p.317)

The proposed research attempts to take on Bettis' challenge by exploring the emerging new paradigm of Mass Customization.

Finally, this research will also contribute to the emerging Mass Customization literature by directly interviewing industry participants. These are the individuals who are currently wrestling with the concept in the real world and will ultimately be responsible for implementing a Mass Customization initiative. Conversations at this point in the development of Mass Customization should open up new ideas and enable a better understanding of their concerns.

1.3 RESEARCH QUESTIONS

The research questions for this project are indicative of the recent emergence of Mass Customization in general, and, more directly, within the textile industry. Given the exploratory nature of this research, the first concern is to model the process under

study. Mass Customization is being touted as a paradigm shift requiring a refocusing of how companies perceive their markets and organize their internal structures and processes (Victor, Boynton, and Pine, 1993; Kotha, 1995). The literature on Mass Customization has not yet put forth an enterprise model describing the linkages necessary to implement a such a paradigm. Therefore, the first research question is:

Q1. Can a model of Mass Customization be developed that is considered valid by leading experts in the field?

If such a model can be established, it will serve as a framework for future research that searches deeper into the individual linkages embedded in the model. A model will also aid managers as they begin considering adopting Mass Customization programs within their firm. Firms will be able to more fully evaluate the difficulties, opportunities, and commitment that are a part of this new approach to their markets.

A second set of research questions deals with how those in the textile industry believe Mass Customization will emerge within their industry. The purpose of these questions is to determine *where* Mass Customization will most likely first appear, *what* types of firms are most likely to adopt Mass Customization, and *who* within the firm will champion the concept. The logic behind these questions is to look at the prospects for Mass Customization at multiple levels: industry level (the *"where"* question); corporate level (the *"what"* question); and, finally, individual level (the *"who"* question). Specifically, the research questions are:

Q2. Does the perceived viability of Mass Customization differ across different sectors of the textile complex?

Q3. Will the adoption of Mass Customization be influenced by corporate strategy?

Q4. What effect does individual functional backgrounds have on determining who might champion Mass Customization within a firm?

1.4 CONCLUSION

The preceding sections addressed why Mass Customization is an important topic to explore, what are the contributions from the proposed research, and the research questions at issue. The next chapters will outline the proposed research. Chapter Two focuses on a review of the literature that serves as the foundation for this research. Chapter Three outlines the proposed Enterprise Model of Mass Customization as well as developing the hypotheses to be tested. Chapter Four addresses methodology issues.

CHAPTER TWO:
LITERATURE REVIEW

This chapter presents a review of the literature related to Mass Customization and is organized into three major sections. The purpose of this chapter is to briefly describe the previous research upon which the proposed research is based.

The first section attempts to place Mass Customization in context by describing how the era of technological change we are now experiencing is enabling Mass Customization. Research from the technology change literature is discussed and related to Mass Customization.

The second section reviews the literature directly related to Mass Customization. It describes the argument behind the assertion that Mass Customization is not merely an extension of another paradigm but is its own paradigm. While this emerging literature is sparse with respect to quantitative research, the conceptual reasoning underpins the proposed study.

A third section extends the review into the important related functional fields of marketing and agile manufacturing. These two fields are not only crucial for Mass Customization to occur but, when applied together with information technology capabilities, separate Mass Customization from other paradigms.

The conclusion for the literature review briefly presents opportunities for extending the research identified in the first three sections and lays the groundwork for the model development phase found in Chapter Four.

Before reviewing the literature it may be useful to discuss how the term, "Mass Customization" is being used today. Like many concepts, Mass Customization has been defined in various ways by different researchers. While the exact wording may differ slightly, most of the definitions center around similar concepts such as variety, flexibility, and competitive costs. In reviewing Pine (1993a) and Davis (1988), Kotha (1995) summarized their definitions as:

> "a process by which firms apply technology and management methods to provide product variety and customization through *flexibility* and *quick response.*"
>
> Kotha, 1995, pg. 22

Similarly, Boynton (1993) focused on products and processes but added the idea of extending the range of customers via Mass Customization. His definition of the concept is:

> "the ability to serve a wide range of customers and meet changing product demands through service or product variety and innovation.."
>
> Boynton, 1993 pg. 47

The operations orientation of the above definitions are aligned with cost consideration by Hart and Taylor (1996). In addition, their definition introduces the role of organizational structure issues. A subtle but important contribution of the definition is how it realistically backs off on promising to provide customers anything they want, anytime, anywhere, and in any way, but suggesting a limit on individualization.

> "Mass Customization is the use of flexible processes and organizational structures to produce varied and often individually

customized products and services at the price of standardized, mass-produced alternatives."

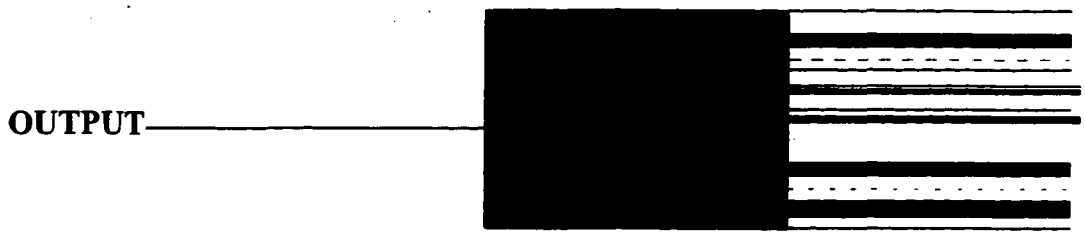
Hart and Taylor, 1996, pg. 4

The above researchers agree that Mass Customization is a distinct paradigm that combines elements of customization from the Craft era with efficiencies of Mass Production. In many ways, it is seen as having the best of both worlds (Figure 3). However, to properly exploit the possibilities inherent within this new paradigm, the researchers also suggest that firms must adapt their systems and structures.

Figure 3

PARADIGM SHIFTS

Moving Forward in Reverse



CRAFT PRODUCTION	MASS PRODUCTION	MASS CUSTOMIZATION
Customized Product	*Standard Product*	*Customized Product*
High Cost per Unit	*Low Cost per Unit*	*Low Cost per Unit*
High Service Content	*Low Service Content*	*High Service Content*
1 - to - 1 Marketing	*Mass Marketing*	*1 - to - 1 Marketing*
Low Volume Output	*High Volume Output*	*High Volume Output*
Artisan Worker	*Assembly Line Worker*	*Module Line Worker*

Perhaps, and almost predictably, the most complete definition comes from Joe Pine (1993a). While incorporating the operational issues, cost consciousness, and customization aspects of other definition, he elevates the concept to a strategic level. This definition enables firms to select the level at which they want to pursue Mass Customization.

> "At its core, it is a tremendous increase in variety and customization without a corresponding increase in cost. At its limit, it is the *mass* production of individually *customized* goods and services. At its best, it provides strategic advantage and economic value."
>
> Pine, 1993a, pg. xiii

With respect to the proposed research study, Hart and Taylor's definition best fits within the scope of this research. It does not require an all-out commitment to Mass Customization yet it strongly focuses the discussion of operational and marketing issues. For these reasons, it will be used during survey questioning to clarify the concept.

2.1 RELATED TECHNOLOGY CHANGE LITERATURE

Advances in technology are the driving forces behind new products, new processes, and, often, new industries. In his seminal work, the economist Schumpeter (1961) trumpeted technology as the primary vehicle for economic growth. He coined the term 'Creative Destruction' to portray a period when a critical mass of assimilated knowledge produces significant advances in technology to the point where the economic factors no longer support the equilibrium of the status quo.

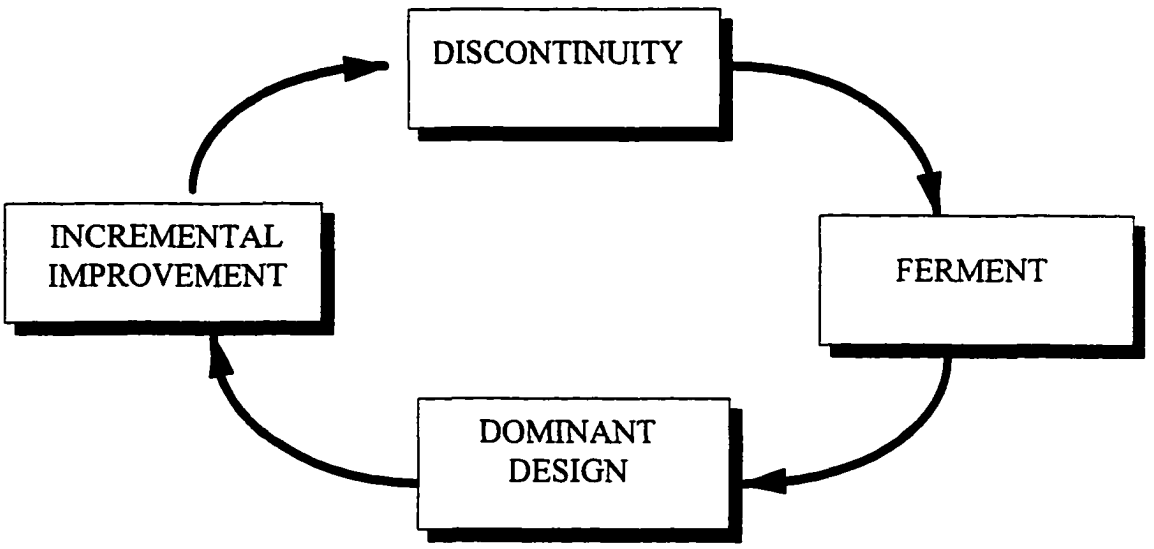
As Schumpeter and others that followed (Abernathy and Clark, 1985; Tushman and Anderson, 1986; Davis, 1987) assert, it is during these periods that new paradigms are born and established. Old mindsets, rules of thumb, industry recipes, and standard processes are challenged and sometimes displaced. Such a period is both an opportunity for the firm adaptive enough to seize the opportunity -- "Fortune favours the prepared firm" (Cohen and Levinthal, 1990) -- and a threat to those firms stubbornly rooted in an outmoded approach. As Schumpeter puts it,

> Competition from the new commodity, the new technology, the new source of supply, the new type of organization ... which commands a decisive cost or quality advantage and which strikes not at the margins of the profits and the outputs of the existing firm but at their foundations and their very lives (p.84).

It is difficult to pick up a business publication without reading how we are currently experiencing a new technological revolution. Toffler (1980) called this period the "Third Wave" that is driven by information technology. These waves of technological revolution reshape industries and companies by enabling an increase in output or allow for the offering of a superior output from a given amount of resources (Rosenberg, 1978). Along these lines, proponents of the Mass Customization paradigm contend that the 'customization revolution' (depicted in Figure 1 in Chapter 1) will allow firms to offer customization at costs comparable to Mass Production.

The concept of the technological change has been studied by scholars from a variety of disciplines. Tushman and Anderson (1986) proposed the "Technology Cycle Model" (see Figure 4) to depict the nature of this phenomenon.

Figure 4
TECHNOLOGY CYCLE MODEL



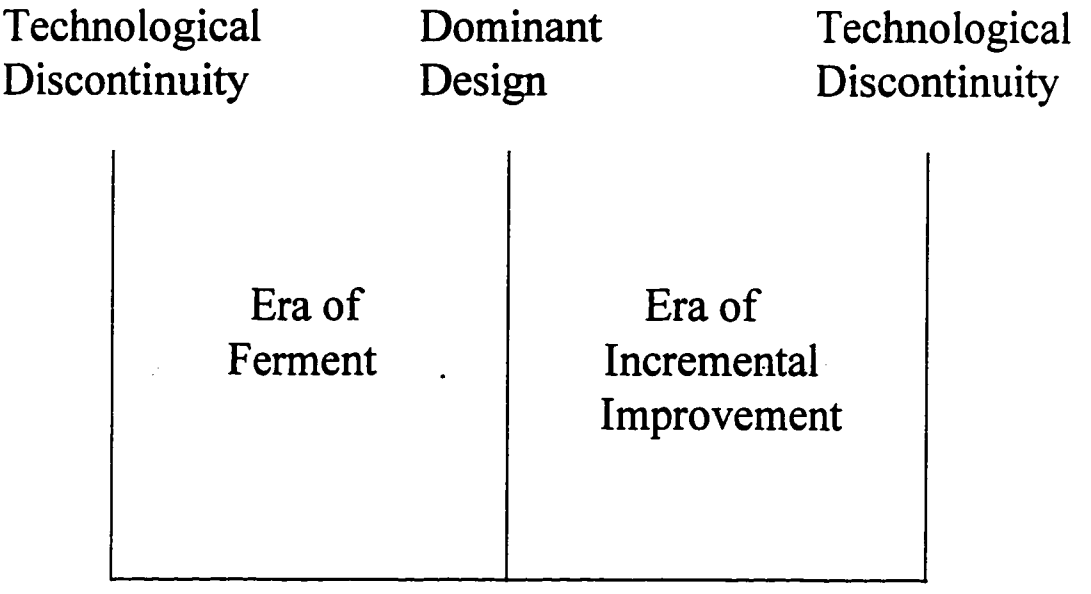
SOURCE: Anderson & Tushman, 1986

The four stages of the model represent different periods of activity as an industry adjusts to a significant technological change. The 'discontinuity' stage is analogous to Schumpeter's 'creative destruction'. After the technological shock reverberates throughout the industry, firms attempt many approaches to adjust, exploit, and alter processes in response to the new environment created by the discontinuity. The "ferment" stage represents this period. Eventually, a successful adaptation is found and adapting firms rally around the establishment of a "dominant design". This dominant design reigns with only minor adjustments (the 'incremental improvement'

stage) until another major technological breakthrough occurs that challenges the status quo of the dominant design. A timeline of this model can be seen in Figure 5.

Figure 5

TECHNOLOGY CYCLE



The proposed study views Mass Customization as a vehicle to exploit the discontinuity created by the new advances in technology. It is believed that we are entering a period where firms will be trying multiple configurations attempting to find the dominant design that allows for customization at a competitive price.

2.2 MASS CUSTOMIZATION LITERATURE

Much of the writing on Mass Customization is housed in trade journals and the business press. The academic literature is rather limited in quantity. However, the quality is conceptually rich. The following review of the literature is limited in the academic literature as it serves as the foundation for the proposed research.

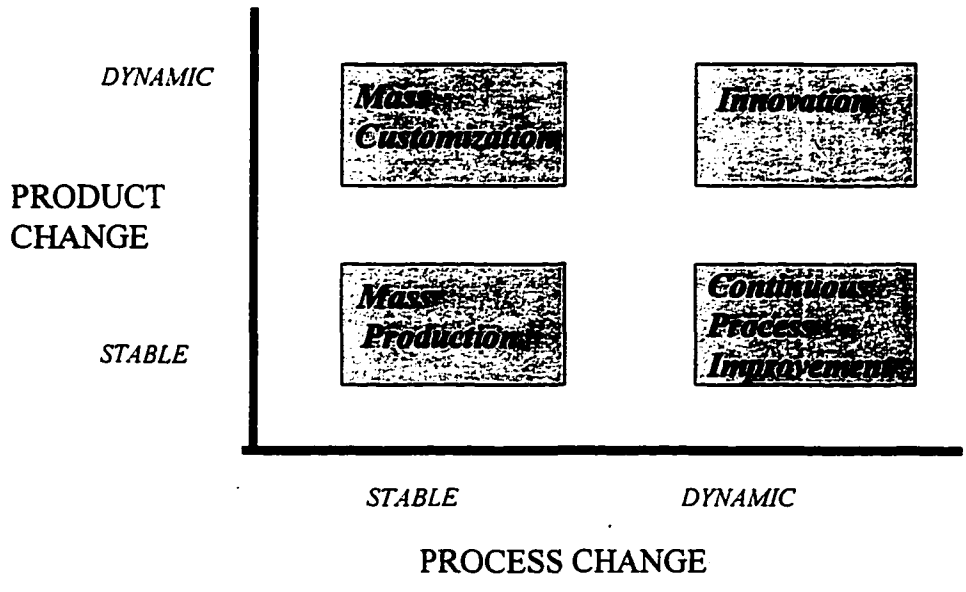
The term "mass customization" first came into the business vocabulary in the book, *Future Perfect* by Stan Davis (1987) when he proposed that the apparent oxymoron represented a new form of business competition. Davis was interested in how technological advances in digitalization and information technologies might impact business. He developed a term to cement his vision that many of the models being used in business at the time were founded on 'false dichotomies' such as *costs versus quality* and *costs versus customization.* These assertions made a strong impression on a group of scholars who used Davis' ideas as a platform to explore this new concept and advance its understanding.

The conceptual underpinning of the field today came from an article by Boynton and Victor (1991) in which they outlined Mass Customization as a separate paradigm and not just an extension of the quality movement. In a simple, yet insightful, two-by-two matrix, they were able to capture the essence of the major business paradigms over the past century -- Craft Production (or Invention), Mass Production, Continuous Process Improvement (the Quality Movement) and the newly minted Mass Customization. They proposed that the distinguishing features which

separate the four business paradigms could be ascertained by looking at how each fit along a *Stable / Dynamic* continuum with respect to their product offerings and the process by which the offerings were produced (Figure 6).

Briefly, it was argued that the process of invention or the unique work of a craftsman resulted in a variety of products via a variety of means (Dynamic Processes / Dynamic Product Offering). The primary aim of the Mass Production paradigm was to stabilize the production process which meant that few standardized products were made (Stable Processes / Stable Product Offering). The 'Quality Movement' sought to improve quality by empowering the workers. By freeing workers to choose their own methods, it was hoped that they would constantly seek incremental improvements and, thus, increase efficiency. However, the Continuous Process Improvement paradigm did not ask the employees to produce a significant increase in the variety of products but focused on improving the process of producing the existing product line (Dynamic Processes / Stable Product Offering). Finally, the Mass Customization paradigm was conceived as a significant increase in product, offering variety which could only be accomplished at a competitive price if the process was stabilized (Stable Process / Dynamic Product Offering).

Figure 6
MATRIX OF PARADIGMS



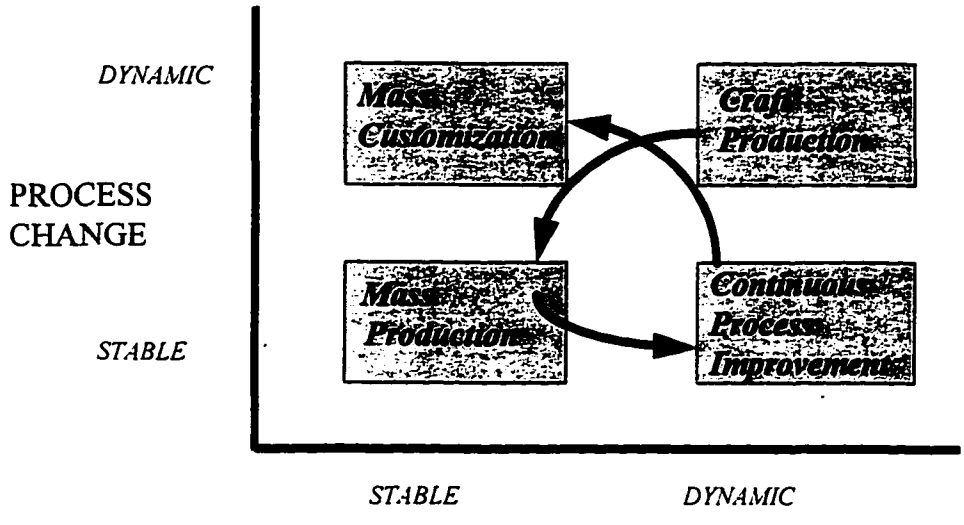
Source: adapted from Victor, Boynton, and Pine, 1994

The term "Dynamic Stability" was coined to embody the requirements of Mass Customization. Firms employing Mass Customization need to develop systems that will enable the process to remain stable even as the products (or services) being produced by this process may be uniquely different from one customer to the next.

In addition to proposing the four-cell model, the researchers suggested that firms could not effortlessly switch to Mass Customization. A transitional path was offered that established the necessary passages that firms must pass through subsequent to Mass Customization (Figure 7). In essence, firms must acquire the requisite skills of the previous paradigms before they could manage the challenge of

the more organizationally advanced Mass Customization paradigm. This contention is certainly open to questioning and could be the source of interesting future research.

Figure 7
TRANSITIONS BETWEEN PARADIGMS



Source: adapted from Victor, Boynton, and Pine, 1994

In a series of articles Pine (1993a, 1993b, 1993c, 1993d) extended the conceptual writings of Boynton and Victor into specific companies that had adopted Mass Customization within their firms. These articles were very important as they enabled the research to begin bringing theory into practice and to learn some of the key elements that are required by Mass Customization in the field. Ultimately, the research formed the basis for the classic book on Mass Customization (Pine, 1993a).

The conceptual and field research merged in an article co-authored by all three researchers that presented their theories and made the assertions that Mass

Customization was so different from the previous paradigms that they could not co-exist within the same company (Pine, Victor, and Boynton, 1993). Kotha (1994) took exception to this notion and sought to challenge it in a study of the National Bicycle Industrial Company, one of Japan's leading bicycle manufacturers. The findings from this extensive case study indicated that Mass Production methods and Mass Customization processes can co-exist within the same firm. However, his description of the operation revealed that the two types of bikes (customized and mass-produced) did not come off the same production lines. In fact, the two lines were separate in many ways and resembled 'focused factories' (Skinner, 1974) housed under the same roof. Kotha wrote of sharing workers and designs. These exchanges were not spontaneous but rather controlled by a system that encouraged scheduled exchanges of both personnel and information. While one can argue about the extent to which cross-fertilization can occur, other important findings should not be lost during this debate.

Kotha (and Pine, also, in many of his case study examples) found that Mass Customization was attainable, profitable and held significant competitive advantages regarding design, marketing, customer relations, production, and operations. These benefits were especially prevalent for those firms that were able to capture the "first mover advantages".

Finally, the most extensive work on Mass Customization to date is Pine's book (1993a). The author traces the evolution of management with clarity and details. The distinguishing features of Mass Customization are frequently highlighted most by

contrasting it against the backdrop of Mass Production. Once the distinction has been adequately established, Pine applies the Value Chain (Porter, 1985) to illustrate how and where Mass Customization can propel a firm to new markets and strategic positions. This analysis is replete with examples and anecdotal evidence.

Beyond establishing a strategic reason for pursuing Mass Customization, Pine addresses some of the operational issues necessary for implementation. However, he does fall short of offering a model depicting how these elements should be arranged.

The only large scale survey found in the literature on Mass Customization is also in Pine's book. The survey contains over 50 scaled questions as well as open-ended questions. Two scales were developed to measure "Market Turbulence" and to construct a "Variety and Customization Profile" for different industry segments. Over 250 participants responded from a variety of industries. As might be expected, it was found that firms in industries experiencing high levels of change and uncertainty ("Market Turbulence") were more likely to be offering more variety and customization ("Variety and Customization Profile").

For the purposes of the proposed research in this paper, the salient issues that can be extracted from Pine's survey include: (1) a resounding affirmation that customization is on the rise in many industries; (2) industry effects do exist; (3) the textile industry was not cited as a well-represented survey participant; and, (4) most importantly, the survey did not attempt to propose nor test a model of Mass

Customization. Pine leaves open questions regarding industry segment effects, implications for the textile industry, and, of course, a model to serve as a framework.

To conclude this discussion of the Mass Customization literature, it is apparent that an enterprise model has not been espoused to this point. The impact of strategy and individual experiences and background has not been investigated. Therefore, it appears that the current proposed research should add to the literature in important ways that may assist future research in this area.

2.3 RELATED MARKETING & AGILE MANUFACTURING LITERATURE

Both marketing and operations management (the academic home for agile manufacturing) has very extensive and involved literatures. The purpose of this review is to highlight the areas of these literatures that are especially pertinent to Mass Customization.

2.3.1 MARKETING AND MASS CUSTOMIZATION

It is not surprising that marketing would play a prominent role in the Mass Customization paradigm since the primary distinguishing feature of this new paradigm is *customizing* the company's goods and services to the wishes of *individual customers*. However, the type of marketing that is being called for requires a paradigm shift with traditional marketing (Peppers and Rogers, 1993; Pine, Peppers, and Rogers, 1995; Hart, 1995). Traditional marketing focuses on market segments -- not individual customers. It focuses on market share of that segment -- not the share

of an individual's purchases. Mass Customization offers great opportunity to capture customers in ways that were unavailable on a mass scale only a few years ago but only for firms willing to fundamentally change how they relate to customers and measure success.

This new marketing paradigm has been coined "1:1 Marketing" by its leading proponents (Peppers and Rogers, 1993). It exploits advances in communication and information technologies to challenge the fundamental tenets of traditional marketing practices. 1:1 Marketing is based on four revolutionary concepts: "customer sacrifice"; "share of the customer"; "customer valuation"; and "learning relationships". Each of these concepts is consistent with and supports Mass Customization.

Customer sacrifice (Hart and Taylor, 1996) is a term specifically designed to suggest there is an opportunity to garner customers that may score high on the traditional "customer satisfaction" index. It is defined as:

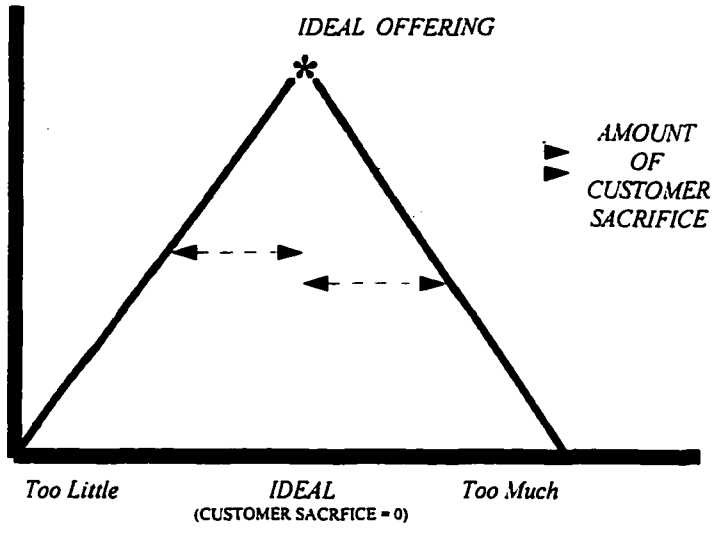
> "the gap between the ideal product-and-service benefits desired by customers, and what is actually available for them to purchase."
> Hart and Taylor, 1996, pg. 11

An individual may be highly satisfied with a company's offering simply because it is the best of what is being offered. However, this customer may still be compromising or 'sacrificing' something (features, style, price, time, etc.) to conduct business with *the best available.* There still may be unmet needs that could easily sway a customer from one firm to another firm. Sometimes these needs could be explicitly identified and sought after but firms are unable to economically meet the

requests. In other cases, the needs may be more latent in nature and are not explicit but would become apparent (as would the "sacrifice") as new product offering possibilities appear. Mass Customization seeks to align "customer sacrifice" with "customer satisfaction" (Figure 8).

Figure 8

CUSTOMER SACRIFICE
versus
CUSTOMER SATISFACTION



CUSTOMER SACRIFICE

Perhaps the most closely cherished concept in marketing is the unswerving belief in 'market share'. 1:1 Marketing rejects this notion as a product of the Mass Production era that is in serious need of overhauling (Peppers and Rogers, 1993; Peppers, 1995). Once you are able to customize to the individual, the market place

shifts from faceless market demographics to individual personalities. Therefore, operational efficiencies are no longer found via the economies of scale inherent in producing identical products to homogeneous, targeted market segments. Instead operational efficiencies result from the economies of scope found in producing multiple solutions for individual customers. A new experience curve based on customer knowledge will become a competitive weapon augmenting the traditional production-oriented experience curve. Under this new marketing approach directed at customizing for individual customers, success will not be measured as a percentage of sales of a particular market segment at a particular time (Market Share). Rather, success will be measured by the share of business the company is receiving from an individual customer's lifetime purchases of the company's product line (Share of Customer). This approach puts a premium on identifying highly valuable customers and on developing a relationship with these highly valuable customers over a long period of time.

As indicated above, it is very important to differentiate among potential customers with respect to their need for customization and their willingness to provide compensation for the effort. "Customer Valuation" (Peppers and Rogers, 1993) represents the process by which potential customers are screened for their potential for profitability and for developing a long-term relationship. In other words, it is the process of seeking out customers for whom it is financially worthwhile to provide customization. This philosophy is counter to traditional marketing where customers

within market segments are basically treated equally. (As an aside to illustrate the power of differentiating one's customers, the authors wrote about a bank that realized after going through a 'Customer Valuation' process that 27% of their accounts were responsible for over 150% of the profits. This meant that 73% of the accounts either provided no returns for the bank, or the bank, in fact, lost money handling the accounts. The power of this technique is significant). Peppers and Rogers are not arguing that firms do not currently target key customers but are proposing that the new technology driving the new paradigm enables firms to expand the level of intimacy beyond just the key customers. Obviously, firms would like to develop an intimate relationship with all of their valued customers.

The final concept, "Learning Relationships" (Pine, Peppers, and Rogers, 1995) is the backbone of 1:1 Marketing. The basic premise is that the only way to profitably justify customization and keep customers from constantly switching companies is to develop such a strong relationship that customers would recognize that there would be considerable "sacrifice" involved with starting the customization process over again with another firm. The only way to succeed at this objective is to make sure the customer feels invested in the company. A strong sense of trust and intimacy become the competitive weapons of 1:1 Marketing. Companies must learn to listen and respond to future as well as present customer needs.

The above description of 1:1 Marketing and its key principles serve to reinforce how Mass Customization is more than merely layering new technology upon

existing systems. The systems must change in order to exploit the new opportunities presented by Mass Customization.

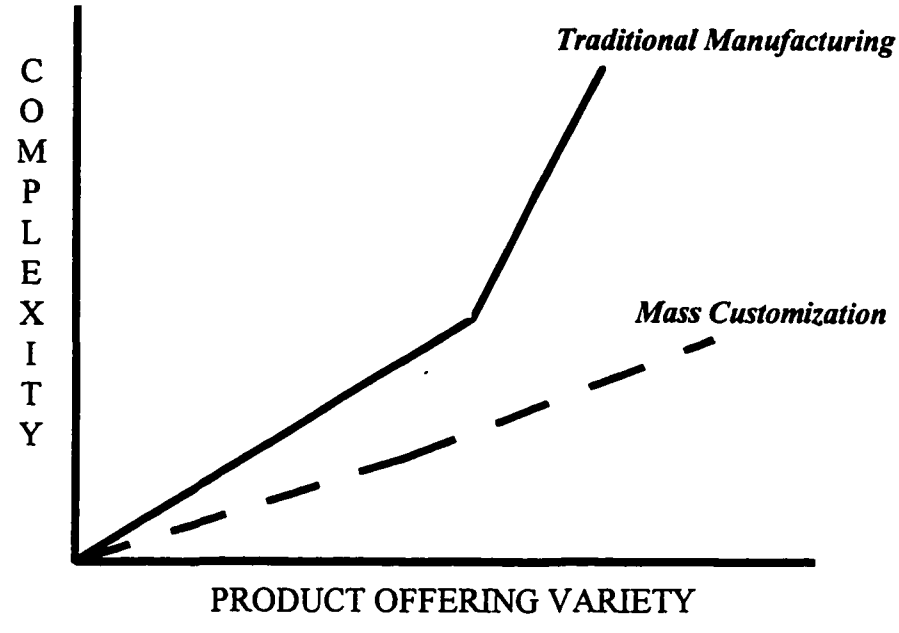
2.3.2 AGILE MANUFACTURING & MASS CUSTOMIZATION

It was mentioned in the previous chapter that customer needs have been stable over time. They want quality at a low price and products customized to their desires. Companies have tried to meet this request for centuries, mostly without success. Historically, firms have been able to only succeed in one area -- price, quality, or customization. Over the past few decades, firms have learned how to produce high quality at competitive prices. There are many that are capable of customizing. But the real stumbling block has been giving quality and, especially, customization at competitive prices. As variety has increased, so have costs.

The Continuous Process Improvement (CPI) paradigm of the last 15 years provided techniques and methods to add flexibility to operations and, thereby, enabled firms to offer more variety. At the operational level, CPI has been more strongly focused on costs, productivity, and quality. At the Strategic Business Unit (SBU) level, flexibility has been clearly a focus resulting in projects and technical teams aimed at significant changes in equipment and processes. However, as customers have become more demanding recently, it is apparent that there are limits to the CPI paradigm with respect to variety. At some point, the complexity associated with adding more variety overwhelms the system and costs skyrocket.

Mass Customization proponents contend that there are circumstances and operational concepts that allow firms to greatly expand their variety without the skyrocketing costs (Figure 9).

Figure 9
PRODUCT VARIETY vs OPERATIONAL COMPLEXITY



The primary factors enabling the Mass Customization curve to appear as it does is agile manufacturing (Goldman, Nagel, and Preiss, 1995). Agility is one of the hottest topics in business today and agile manufacturing is the heart of agility. Defining agility is very difficult as it is often used in conjunction with other terms and concepts (Dove, 1996). However, some of agile manufacturing's most basic tenets are critical for Mass Customization. Agility provides flexibility, speed, and variety. Manufacturing flexibility is a growing literature (Gupta & Somers, 1992; Upton,

1995a; Upton, 1994; Dixon, 1992; Suarez, Cusumano, and Fine, 1995). Flexibility is now classified as a multi-dimensional concept. Cited dimensions of flexibility include mix flexibility, volume flexibility, product flexibility, and range flexibility. For Mass Customization purposes, it is not so important to be flexible generally as it is to be flexible specifically along the dimension on which you are customizing.

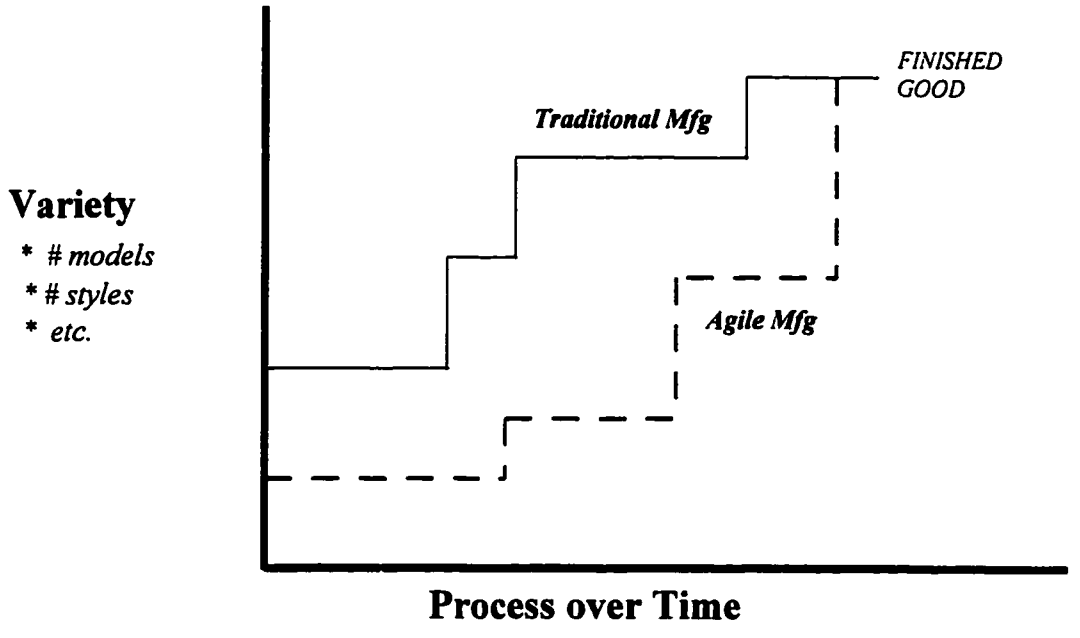
A critical aspect of agility for Mass Customization is its emphasis on cycle time reduction. For Mass Customization to work at competitive costs, the set-up and changeover times have got to be very short. Agile manufacturing addresses these concerns with modular manufacturing, design for manufacture (DFM) techniques (Anderson, 1990), and the utilization of Computer Integrated Manufacturing (CIM) (Goldhar and Lei, 1995).

Another approach to reduce the complexity and, hence, the costs of coordinating complexity is to restructure the sequencing of operations to postpone complexity as long as possible (Figure 10). Digital printing would be an example of a new technology that would allow textile manufacturers to postpone commitments to colors or patterns. This delay would allow for standard operations to produce a larger share of the total product.

Agile manufacturing is truly one of the critical pillars supporting Mass Customization efforts that exist today and will only become more important in the future. As cycle times decline, Mass Customizers can be closer to their goal of a lot size of one.

Figure 10

Managing the COMPLEXITY CURVE



*The **Area Under Each Curve** represents the **Level of Complexity** needed to offer variety*

2.4 THE OPERATIONAL ISSUES OF A NEW PARADIGM

The previous sections of this chapter addressed the "What is Mass Customization?" question and described the current literature for this emerging field. Most of the discussion has been at the conceptual level in an attempt to distinguish Mass Customization from previous business practices. The concept of a "paradigm shift" has been tossed around lately to describe recent new business ideas. This liberal use of the term has, unfortunately, diminished its value and tends to make many skeptical of anything that is described as a new "paradigm". Too often the term has been applied to extensions of previous, established practices and not limited to truly

new approaches. The purpose of the following sections of this chapter is to explain in detail why Mass Customization really is a new "paradigm" and not merely the latest extension of a familiar approach.

In order for a new approach to be a "paradigm" shift, it first must be accepted as a new way of thinking about an issue and, second, it must require a new operational approach in order to achieve the intended goal. To change the way of thinking without having to change operationally reflects an *extension* of the same practice. By the same token, to change how things are done but retain the same thinking is an *adjustment* to the existing paradigm. There is absolutely nothing wrong with extending or adjusting an established paradigm. In fact, these incremental improvements are often the wellspring of considerable profits at relatively minor expense. However, adjustments and extensions are not paradigm shifts. To achieve a paradigm shift one must fundamentally change what he/she is doing *and* how it is being done. While many are capable of adjusting or extending existing approaches, far fewer have the organizational vision, capacity, and culture necessary to successfully achieve a paradigm shift. That fact explains why great fortunes are often associated with forging or taking advantage of paradigm shifts (e.g., Rockefeller, Ford, Carnegie during the Mass Production paradigm shift and Gates during the informational era).

The Mass Customization paradigm requires substantially different skills and approaches than previous paradigms. Table 2.1 attempts to illustrate these distinctions by contrasting key organizational dimensions across multiple paradigms.

TABLE 2.1

CHANGING PARADIGMS

	MASS PRODUCTION	CONTINUOUS IMPROVEMENT	MASS CUSTOMIZATION
CORPORATE ISSUES:			
STRATEGIC FOCUS	*COST / EFFICIENCY*	*QUALITY / RESPONSIVENESS* *Given:* Cost Control Efficiency	*CUSTOMIZATION* Given: Cost Control Efficiency Quality
CRITICAL ORGANIZATIONAL FACTOR	*ENGINEERING*	*ENGINEERING / MGMT SYSTEMS / FLEXIBILITY*	*FLEXIBILITY / COMPLEX COORDINATION / INFORMATION SYSTEMS*
OPERATIONAL ISSUES:			
1) ORGANIZATIONAL			
PRODUCT LINE	*STANDARD* *Long Production Runs*	*VARIATION OF STD* *Long Production Runs*	*CUSTOMIZED* *Short & Batch Runs*
FACTORY FOCUS: Internal Systems External Relations	*INTERNAL*	*INTERNAL /external*	*EXTERNAL / INTERNAL*
ORG'Z STRUCTURE	*CENTRALIZED / BUREAUCRATIC*	*TEAMS*	*MODULES (internal)* *VIRTUAL (external)*
EMPLOYEES *(Management view of)*	*SPECIALIZED* *- cost centers*	*CROSS-TRAINED* *- assets*	*RESPONSIVE TO CUSTOMERS* *- sources of value added*
MANAGEMENT	*CLOSE SUPERVISORS*	*COACHES / FACILITATORS*	*ARCHITECTS / BOUNDARY SPANNERS*

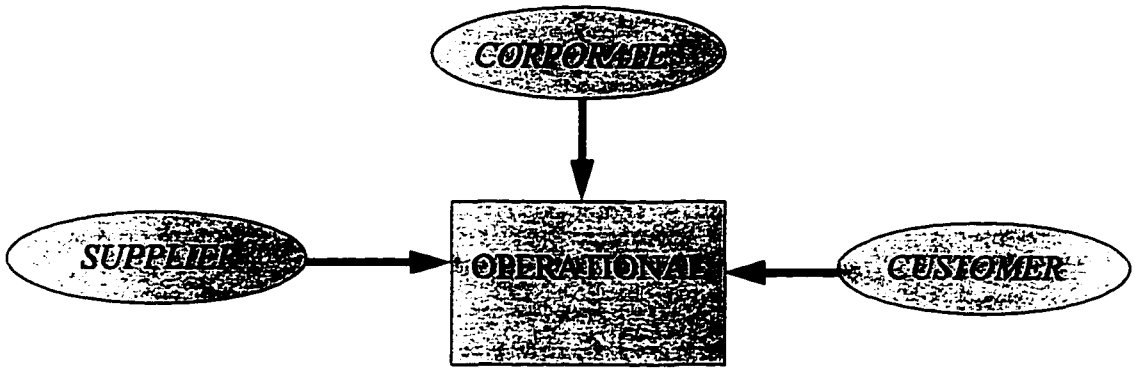
TABLE 2.1 (continued)

	MASS PRODUCTION	CONTINUOUS IMPROVEMENT	MASS CUSTOMIZATION
2) FUNCTIONAL			
MANUFACTURING's ROLE	*EFFICIENCY*	*QUALITY*	*AGILITY*
INVENTORY CONTROL	*EOQ*	*JIT*	*ON-DEMAND*
MARKETING's ROLE	*MASS MARKETING*	*MARKET SEGMENTATION*	*1- TO - 1 MARKETING*
MIS's ROLE	*HISTORICAL RESULTS* *- post production*	*MONITORING*	*ENABLING / STRATEGIC*
Hope for CIM	*ROBOTICS* *- difficult to justify*	*"LIGHTS OUT"* *- disappointing*	*INTEGRATIVE* *- adaptive & functionally driven* *- enterprise-wide*
ACCOUNTING SYSTEM	*STANDARD COSTING*	*FLEXIBLE COSTING / EARLY ABC*	*ACTIVITY-BASED COSTING* *(or next generation)*
EXTERNAL ISSUES:			
CUSTOMER's ROLE	*PURCHASE ORDER*	*CUSTOMER SURVEY* *- "Voice of Customer"*	*CUSTOMER DRIVEN* *- high involvement* *- customer as designer*
SUPPLIER's ROLE *(key consideration)*	*ADVERSARIAL* *- multiple suppliers* *- price breaks* *- high volume orders* *(cost containment)*	*PARTNERSHIP* *- single source* *- mutual dependency* *- quality* *(consistency / reliability)*	*ALLIANCES* *- close network* *- electronically linked* *- small lots* *(speed / flexibility)*

Table 2.1 divides the organization dimensions into the three broad categories of *Corporate, Operational,* and *External* issues (Figure 10). The Corporate issues have been discussed throughout this chapter so there is little reason to repeat those points. The remainder of the chapter focuses on the Operational and External issues associated with Mass Customization. Hopefully, by the end of this discussion, a clear distinction will emerge between the Mass Customization paradigm and the other major business paradigms of today.

FIGURE 11

ORGANIZATION DIMENSIONS



Operational issues include the product offering, the operational emphasis of the factory and its structure, the value placed on employees, and the managerial styles associated with each paradigm.

2.4.1 Organizational Issues

Product Line: The product offerings available to the customer vary tremendously across paradigms. The Mass Production disciples of Henry Ford and Frederick Taylor believe in the efficiency of a standard product offering. While the customer focus of the CPI model forces firms to increase their variety of offerings, it is still typically subtle variations of the standard offering. However, the very nature of Mass Customization is to offer a much wider array of product offerings limited only by the available technology and internal efficiency.

Factory Focus: Traditional factories using the Mass Production model have little contact with suppliers and even less contact with customers. Customers are considered "Marketing's problem". CPI organizations try to determine customer needs through some level of surveying prior to production. While recognizing the important roles played by suppliers and customers, the internal factory focus is still the dominant mindset. The performance measures are still primarily operational in nature (e.g., defect rates, cycle times, production rates, etc.). Due to the quick turnaround nature of the Mass Customization paradigm, the entire organization needs to be far more focused on customer and supplier relations. A much more balanced emphasis of internal and external focus is required of a Mass Customization operation.

Organizational Structure: The centralized, bureaucratic structure that symbolizes Mass Production has taken quite a beating over the past few decades. There is not anything wrong with the internal consistency regarding the paradigm's primary principles (Fayol, 1948). It is just that such a model is no longer viable in the environment in which most domestic textile firms find themselves today. The CPI model, on the other hand, is tightly associated with teams and employee empowerment (although certainly practiced with varying levels of commitment and success). Making the transition from the mechanistic bureaucratic structure of Mass Production to the more organic structure found in the CPI model has been painful for more than one textile firm and, unfortunately, impossible for too many others. But this change has to be made if Mass Customization is to have any chance of becoming more than a theoretical concept in this industry. The "modular" structure now being advocated as the operational basis for Mass Customization (Pine, 1993d; Boynton, Victor, and Pine, 1993) requires the flexibility learned by CPI firms. In addition to the modular structure internally, Mass Customizers need to develop much tighter linkages with suppliers, outsourcers, and customers. Some have called this type of relationships "virtual" to indicate that the operational requirements are still accomplished but not necessarily under one roof or by one firm but are spread out virtually to whoever can best meet the requirements. The fluid nature of Mass Customization will encourage firms to enter into these virtual linkages as firms

attempt to alleviate or share business risks. The skills and consequences of maintaining these virtual arrangements are both critical and uncertain.

Employees: A significant and positive transition in how employees are perceived by management is apparent as one moves from Mass Production to Mass Customization. In Mass Production employees are costs to be minimized. The whole premise behind Scientific Management (Taylor, 1911) is how to improve the efficiency of workers. The primary idea behind "specialization of labor" and "division of labor" is to compartmentalize worker effort into small, discrete tasks so workers can be as predictable as the machines that spawned the Mass Production revolution.

Fortunately, the CPI paradigm advocates recognize the waste and inefficiencies which result from treating employees as robots. Employees are viewed as assets that can contribute through their flexibility and decision-making ability. Cross-training programs are devised to take advantage of these abilities by developing employees in multiple areas so they can help the organization where and when they are most needed.

The logical next step for these cross-trained employees is to allow them to get beyond the factory walls and deliver value-added service directly to customers and suppliers. As customers, suppliers, and producers become electronically linked and more dependent upon one another, everyone in the organization will need to be responsive to these external relationships. Management will not be empowering workers out of a sense of altruism but rather for sound economic reason. It will be a vital strategic imperative that everyone is involved, dedicated and responsive. As Tom

Peters puts it, successful organizations of the future will be those that turn everyone into a "businessperson" (Peters, 1994).

Management: The role of management in the three paradigms closely mimics the classic Theory X and Theory Y debate (McGregor, 1960). Theory X managers believe that workers are lazy and try to minimize their effort. Therefore, the role of the manager in Theory X is to closely supervise their employees. The control of the organization is considered to be in the tight grips of management. The classic bureaucratic management principle of "span of control" is very important in Theory X and is embedded in the Mass Production paradigm.

The Theory Y managers believe that workers want to do interesting and challenging work. Employees want to be able to take pride in their work. Therefore, the role of the manager shifts from supervision to an enabler who coaches employees and tries to facilitate their needs so they can perform at the levels they strive to achieve. Control of the organization is now shifted to the hands of the employees. As Bill Gore, CEO and founder of Gore, Inc. once said, "We cannot run the business. We learned over 25 years ago to let the business run itself.... Commitment, not authority, produces results."

The role of management in Mass Customization goes beyond Theory Y and adds the responsibilities of architect and boundary spanning. The management must design a system that seamlessly coordinates customers, suppliers, and operations through instantaneous communication and flexibility. Management must span the

boundaries of the traditional organization and manage the complex relationships in the virtual organization. An organization that attempts to do this layering of Mass Customization technology on an existing Mass Production hierarchical system is doomed to almost certain failure. This insight alone may be the ultimate reason why some firms will not be able to fully make the transition to a level of Mass Customization that is beyond additional product offerings to a level that leads to a real competitive advantage.

2.4.2 Functional Area Issues

Manufacturing: Manufacturing's role is the central piece of the discussions regarding these paradigms in this paper. Manufacturing efficiency is king in the Mass Production model. The CPI paradigm still maintains a strong emphasis on efficiency but adds a strong focus on quality. To manufacture customized products, firms must not only emphasize efficiency and quality but they must develop the current agility concepts prominent in the literature today (Goldman, et al; 1995).

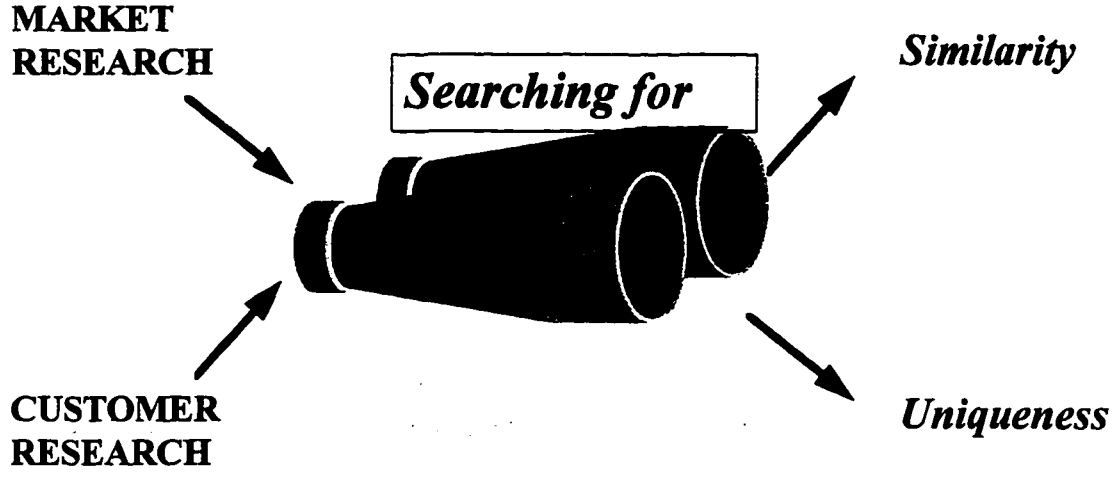
Inventory Control: Inventory has always been an important cost to production and has been the focus of much research and innovation through the years. Mass Production operations incorporate systems such as Economic Order Quantity (EOQ) and Material Resource Planning (MRP and MRP II) in order to better control inventory. As the costs of inventory continued to escalate in recent decades, new methods came into vogue. Most CPI firms attempt some form of Just-In-Time (JIT) inventory control where the goal is to minimize the amount of inventory that is

physically stored in the plant. Such a system requires tight coordination with suppliers who could be depended on for reliable delivery and consistent quality. Mass Customizers try to minimize inventory by producing to order. In order to do this in a reasonable timeframe, the firm must have access to supplies almost on demand. The relationships built between CPI firms and their suppliers must be expanded upon to include more suppliers in order to have such access.

Marketing: As argued above, Mass Customization requires a much closer, almost personal relationship to develop between the provider and the customer. The idea is to develop a bond with the customer that will enable the firm to capture a higher proportion of the share of that customer's future purchases. This fundamental shift requires an entire transformation in the way business thinks about marketing to their customers. Marketing under the Mass Production model was concerned with uncovering groups of potential customers sharing a common need. In Mass Customization, this logic is turned on its head and the search now becomes identifying how these potential customers are unique in such a way that they will make a purchasing decision based on that dimension. The transformation that the marketing department must make to market in the Mass Customization paradigm is depicted in its most basic form in Figure 11.

FIGURE 12

"MARKETING" vs. "CUSTOMERING"



The three keys to successful Mass Customization marketing are:

1) Identifying the "Most Valuable Customers"
   - *profitable, frequent, loyal*

2) Viewing the Customer as a Lifelong Customer
   - *"share of the customer"*

3) Developing "Learning Relationships" with Customers

How will a firm possibly provide such intimate customized service to a mass market? The key is to develop the Information Technology (IT) competencies needed to develop a simple-to-use database that is elegant and sophisticated enough to

capture, retain, massage, and present the key customer information throughout the organization instantaneously. In other words, "high touch" using "high tech".

Role of MIS: As stated above, Information Technology is one of the primary enabling forces of Mass Customization so it is not surprising that the role of MIS is substantially elevated in this paradigm. Information Systems were used primarily as historical data accumulators or forecasting aids in the Mass Production paradigm. Operational results became available in more detail and depth than ever before. However, MIS was still outside the box of the production process. As time went along, Mass Producers slowly incorporated more MIS concepts but not the extent of the CPI firms. CPI firms realized that finding out how they did after it was over was sometimes too late. These firms turned to IT to monitor the process as the production was in operation. Most modern textile machinery today possess on-line processors that constantly monitor performance and alert operators as problems arise. Production data, inventory, and purchasing are linked electronically. MIS is elevated to a decision making tool that not only informs and monitors but also controls aspects of the business.

Mass Customization requires firms to continue down the path of the CPI paradigm while broadening the linkages to operations of firms outside the production process. Mass Customization is realistically possible only if information is quickly shared among all necessary constituents. In this way, MIS can be considered to be enabling Mass Customization and becomes a major strategic issue for this paradigm.

Role for CIM: While the role for MIS in the Mass Customization paradigm is pretty clear, the role for CIM is clear in theory but murky in practice. In order to quickly individualize each product, it will be necessary to develop a system of rapid changeovers. The frequency and complexity of these changeovers almost dictate a role for CIM in any large-scale operation. The "Personal Pair" division of Levi Strauss that customizes women's jeans relies on a highly computerized single ply cutter (Rifkin, 1994). Without this technology customized jeans would remain only in the realm of the local tailor. Although the promise of CIM technology is crucial to Mass Customization, it is also the most poorly understood or conceptualized element of the paradigm. What is fairly well understood is that it will have to be different from what was conceptualized in the previous paradigms.

Mass Production looks to robotics as a means to take advantage of CIM technology. Much like everything else in this paradigm, robots would be designed to do specialized tasks currently being done by humans. While there were some technological challenges regarding dexterity and the like, the real challenge to robotics was economic. It is very difficult to economically justify a substantial level of investment in robotic technology for anything short of a very large-scale operation. A new method of economic justification other than Net Present Value (NPV) will have to be considered in future investment decisions.

As electronic sensors and software became more sophisticated, CIM proponents began to visualize the "lights out" factory. Once again, reality did not

measure up to the vision but considerable strides were made in CIM. Much like MIS in Mass Customization, the role of CIM in this paradigm will be an extension of past advances and experiences. One defining feature of CIM in Mass Customization is that its role will be designed from the enterprise level and not from the engineering level. CIM will be designed and developed to support the organizational strategy and not because the technological capability allows it. The dog will wag the tail more frequently.

Accounting System: Accounting systems have often lagged behind production systems throughout this century. Once Mass Production became firmly rooted in American business, accountants needed to develop a system to track the costs incurred. Eventually, the traditional Standard Cost System was developed with its emphasis on attaching costs product by product. Overhead was typically allocated by labor hours. This allocation scheme was justified because labor was a significant cost component and considered tightly related to the utilization of overhead. As automation became more prevalent in Mass Production, allocating overhead on the basis of labor hours became more problematic and inaccurate. It was obvious that the Standard Costing System was fundamentally lacking.

Initially, Flexible Costing Systems were developed to more closely approximated the real costs. However, even this cost system became stretched as TQM processes changed how products were manufactured. People started questioning

the wisdom of trying to attach costs to products instead of to the processes that actually drive the occurrence of a cost.

Slowly, the accounting profession began adopting elements of Activity Based Costing (ABC) Systems. These systems attempt to replace arbitrary allocations based on a fixed allocator (i.e., direct labor hours) with "cost drivers". These cost drivers are the activities that cause costs to be incurred in the process. ABC systems focus on processes instead of products. A Big 3 automaker reported that after adopting a version of ABC, it realized that its previous accounting system was inaccurate by an average of 40% across its entire manufacturing system.

The shift to ABC is a significant change in how cost accounting is practiced. As with most significant changes, it received its share of resistance. While ABC systems are now accepted as viable alternatives to the traditional Standard Costing or Flexible Costing systems, there is still much debate on just how much more accurately it captures true costs. There is, however, very little debate that a better system is needed as production systems have again eclipsed Accounting's ability to accurately reflect operations. Since Mass Customization is, by definition, going to require individualized products, it is imperative that a cost accounting system is devised that can guide pricing and production decisions. It may be a variation of the ABC system or the next generation of accounting systems. The capability to better track costs in a Mass Customization arena will be a significant competitive advantage to the firm(s) that can achieve this ability.

2.4.3. EXTERNAL ISSUES

Customer's Role: The role of the customer changes dramatically from one paradigm to another. Henry Ford's earlier quotation may be a slight exaggeration but it does reveal the importance that the Mass Production paradigm places on involving the customer in decisions. While market research is certainly done by Mass Producers, there still remains a sense of "build it and they will come" mentality.

Many believe that the arrogance often attributed to major U.S. producers in the past contributed to the decline in market share that ultimately forced many firms to adopt the CPI paradigm. One of the main tenets of TQM is to become "customer focused" and to listen to the "voice of the customer" (Winchester, 1994). Customers may not have been king during the CPI era but at least they were welcomed in the palace.

As with many other of the aspects discussed above, Mass Customization moves the CPI doctrine farther down the path. In Mass Customization, the customer is heavily involved with the producer. In many respects, the customer is involved in the actual design of the product or, at least, in the selection of its components. This tight relationship demands that firms reevaluate their interactions with their customers. If one needs to market to customers individually, then one will need to involve them individually (hence, 1-to-1 Marketing).

The Role of the Supplier: How a firm deals with its suppliers is structurally and competitively altered as one moves across the three paradigms. The classic

relationship in the Mass Production model is adversarial. Suppliers negotiate for the highest price while buyers attempt to bargain down the price. Since the focus of this paradigm is efficiency, it is only natural to view this relationship as an opportunity to contain costs. Firms traditionally use multiple suppliers in an effort to force a bidding war. Suppliers, on the other hand, have their own set of tactics, such as volume discounts, to counterbalance the situation.

However, the relationship took on a different look as firms began competing on quality. Instead of strictly dealing on cost containment, firms needed a reliable and consistent source of product. Innovated methods, such as JIT, revealed to both suppliers and producers that the relationship was not necessarily a zero-sum game. Both sides realized that they could benefit from a partnership in which both sides won. Manufacturers win by receiving quality parts that enable them to reduce inventory and storage costs while suppliers could better service their customers through the strong relationships. Today, many firms "single source" much of their needs through "strategic partnerships". These words were not part of the business vocabulary during the Mass Production era.

It is not as clear what the relationship will be in the Mass Customization era. There is little doubt that the quality, reliability, and consistency inherent in many partnership arrangements will still be valued. However, speed and flexibility will take on additional importance. A single firm may not be able to meet these needs alone in the timeframe required by Mass Customization. It may be financially infeasible and

operationally unreasonable for a single firm to have both the flexible capacity and the flexible capabilities to meet all the needs of a Mass Customizer. It is more likely that an electronically linked network of firms will be needed to service the demands of this paradigm. Elements of the virtual relationships suggested above are very likely.

2.4 SUMMARY

The above sections attempted to describe the Mass Customization paradigm, its cited benefits, and how it is structurally and operationally distinct from the past paradigms of Mass Production and Continuous Process Improvement. The differences are far more than mere semantics. Significant organizational and operational changes must be implemented to compete in the Mass Customization environment.

At the present time, the key elements of Mass Customization have not been fully identified nor has an implementation model been developed. Firms are still searching for these aspects. However, there is a growing feeling that pursuing Mass Customization will eventually justify this search process.

CHAPTER THREE:
MODEL DEVELOPMENT & HYPOTHESES

The previous chapters introduced the purpose behind the proposed study and theoretical concepts underpinning the development of the research. Chapter Three begins by outlining the development of an Enterprise Model of Mass Customization and concludes by extending the research questions posed in Chapter One to a set of testable research propositions.

3.1 MODEL DEVELOPMENT

As indicated in Chapter 1, a primary objective of this research is to begin the establishment of a research framework upon which future researchers can build. The literature reviews of the previous chapter identified some of the key factors that need to be contained in a model of Mass Customization but did not provide an explanation of how these individual elements are to be linked in a system that supports Mass Customization. The primary researchers in the field have all implied a coordinated system of processes but none of them have attempted to explicitly present the system (Pine, 1993a; Boynton & Victor, 1991; Kotha, 1994). The purpose of this paper is to portray a system that does, in fact, link the operational processes that the literature suggests make up the major elements of Mass Customization.

The model outlined below is certainly a first step in the development of a research model. It is truly exploratory research in the vein recommended by Bettis

(1991). It is anticipated that the validation process outlined in Chapter Four will provide invaluable information to improve the proposed model.

The model is presented in Exhibit 1 (located just prior to the Appendix at the end of the paper). It is not suggested that there is only one way to design a Mass Customization operation nor does it infer that certain elements *must be* present in order to classify an operation as utilizing Mass Customization processes. The purpose of this model is to incorporate the technologies and practices available today that best support Mass Customization. It is a generic model at the Enterprise level. Obviously, firms may pursue Mass Customization with different strategic or operational objectives in mind and would adapt the process to their interests.

However, it is being asserted that a Mass Customization operation should possess certain principles that are guiding the selection of individual processes and how they are being configured in a system. One such principle is that customers need to be involved in the production process beyond just placing the order. The range of possible involvement is quite wide, from selecting from a menu of possible components to actually co-designing the product. Obviously, the more involved the customer is, the more customization is likely imbedded into the final product. The goal of this involvement is to develop a level of intimacy between the organization and its customer that is consistent with the methods of 1:1 Marketing.

A second principle associated with a Mass Customization operation is a pursuit of process agility. In order for a Mass Customization operation to compete

with the Mass Producer it must be able to reduce changeover time to a minimum. How this agility is accomplished in individual settings is not really the issue as much as it is a certainty that this flexibility in operations is of paramount importance.

Finally, a third principle to be followed by Mass Customization operations is an emphasis on communication of information. Again, it may not necessarily take the form of an elaborate information system but what is predictable is that the rapid communication of accurate information will be seen as a critical success factor within the firm. The particular systems and techniques used may vary but the commitment to this principle will not waver.

The next few paragraphs will describe the proposed Enterprise Model of Mass Customization. Since this paradigm places enormous importance on the customer, the description will begin with how the customer first makes contact with the firm and then proceeds to track the process through the system until the product is delivered to the customer. Essentially, the discussion will move through the model from left to right.

Assuming this is the first time the customer has dealt with the company, the link will probably be established via a traditional marketing vehicle (e.g., direct mail, commercials, world-wide web, etc.). No one is contending that traditional marketing is going to become extinct because of '1:1 Marketing'. The two approaches are very different but can complement one another very well. Once contact with the customer has been made, a company individual will provide 'Customer Servicing' (not customer

service). The role of customer servicing is to help guide the customer through the selection process. With today's communication technology this exchange can occur face-to-face or electronically. The only real requirement is that the exchange has an interactive feature so information can not only be exchanged but captured.

To coordinate, organize, and stabilize the system, this process will use a 'Sales Assistance Device" (SAD) that is linked with multiple other systems. The SAD may be linked with an expert system or similar device to help design a selection consistent with the wishes of the particular customer. It will probably function as a Graphical Order Configurator (GOC) which will not only aid in the selection decision but can also accurately translate that order to engineering and manufacturing systems. Orders can be translated into part numbers and fed into an Enterprise Resource Planning (ERP) system to initiate the manufacturing process.

The customer may design any number of alternative selections to choose from so a price must be established for each configuration. Therefore, SAD must be linked with the accounting system, preferably an Activity Based Costing (ABC) system. The ABC system attempts to allocate costs to products by determining what costs were driven by the product request. Since Mass Customization individualizes offering, each product should have different cost structures attach to it. (Note: at management's discretion, two customized products may be offered at the same price for strategic reasons but it is highly unlikely that their costs structures are exactly the

same). As will 1:1 Marketing and Agile Manufacturing, the new industrial era needs new accounting techniques to support the new ways of business.

The customer order is now placed. All of the linkages between systems should be seamless and transparent to the customer. At this point, the model can be dealt with in two sections: the customer/marketing linkages and the operational linkages. It should be emphasized that the two sets of linkages are being separately addressed here in the interest of clarity whereas, in theory, they are intertwined and share influence over the other. The marketing linkages will be discussed first.

3.1.1 MARKETING LINKAGES WITHIN THE MODEL

Once the order has been successfully accepted, information about the customer and his/her preferences are fed into the Individual Customer Database. Information from this database is then shared with the firm's Marketing Learning Module where the information is updated and massaged. The customer database can be the source of individually targeted marketing announcements as well as a wellspring of information for the next employee serving in the Customer Servicing role. The company is now "learning" more about the customer and will be better able to establish the desired intimacy for a long-term relationship.

The Marketing Learning Module will not only improve the individual customer database but it will feed information to the Marketing Module. The role of the Marketing Module is two-fold. First, it will act as a traditional marketing arm of a

firm and, hopefully, discern trends within the firm's industry. In this capacity, the Marketing Module will attempt to attract new customers to the company by offering products that are consistent with current trends. At the same time, the modules will be coordinated with operations to make sure the company has the operational capabilities to produce the product. If a product area is "hot" but the firm does not possess the capacity to produce it on demand, then it should not offer the product via SAD. One of the roles of the Marketing Module is to assist operations with projecting what capabilities need to be acquired. These projections will turn into the Operating Modules that actually produce the product. Unlike traditional marketing, the Marketing Module is not really forecasting sales numbers but rather forecasting required capabilities.

3.1.2 OPERATIONAL LINKAGES WITHIN THE MODEL

While the marketing linkages concentrate on using information to build intimate relationships, the operational linkages must fulfill the customized order. The linkagees are responsible for delivering what the Sales and Marketing areas have promised (I guess some basic things do not change even during paradigm shifts).

The Graphical Order Configurator obtains the pertinent operational information following the SAD exchange with the customer and notifies the Operations IS Module of the order and the required components. This information is relayed to systems which schedule the work (Real Time Scheduling), design the work

process, interact with outsourcing suppliers (EDI or Internet-based services such as EINet), and organize downstream logistics. Each module is coordinated to produce the product in a dynamic yet stable environment.

The real key to these operational linkages centers on the Flexible Operational Modules. These systems must be designed to reduce the cycle time for set-up, changeover, and supplying raw material. Opportunities for Computer Integrated Manufacturing (CIM) abound in this environment. Employees must be trained to work within a structured system in which each product may be different from the previous one. To reduce parts inventory, complexity, and costs, a strong multi-functional team effort must be in place prior to adding a new product. The output of this team effort should be products that are designed for manufacturing (DFM). Whenever possible, parts, components, processes and equipment should be designed to be flexible and interchangeable (Anderson, 1990).

Modules produced in-house are combined with outsourced modules to assemble the product to the customer's specifications. At this point, the Logistic Module takes over and begins the process of distributing the products to individual customers. The delivery segment of the process is yet another opportunity to learn more about the customer. Employees at this end of the process need to be trained to collect and input information gathered during their interactions with the customer. The information will be transferred into the Marketing Learning Module to update both the Individual Customer Database and the Marketing Module.

3.1.3 MODEL DEVELOPMENT CONCLUSION

The model outlined above is truly an enterprise level model. It encompasses marketing, accounting, manufacturing, and distribution. Although many of the references were to more recent techniques and technologies, this is not to say that Mass Customization has to be a high tech process. The key is to find a way to stay true to the critical principles supporting Mass Customization. If this can be done without technology, fine. However, it does seem plausible that technology will become even more prominent with time.

3.2 HYPOTHESES GENERATION

In Chapter One a series of research questions was presented. The questions centered on the perceptions of textile industry participants to the emerging paradigm of Mass Customization. Specifically, the questions of interest were *where* might Mass Customization enter the textile industry in a significant way; *what* types of organization issues lend themselves to Mass Customization; and *who* are the likely individuals to assume a leadership role regarding adopting Mass Customization within the textile industry. These questions address issues at the industry, corporate, and individual levels. The following paragraphs will convert these research questions into five testable hypotheses.

3.2.1 HYPOTHESIS 1

Researchers in fields of industrial organizational economics (Scherer, 1980) and strategic management (Porter, 1980) have deeply believed and extensively studied the impact of industry on organizational choice. The textile industry, as defined in this study, ranges from fiber producers to apparel. This range of textile industry sectors spans from highly capital intensive and highly automated processes to very labor intensive processes. In some ways, the broadly defined textile industry is almost a microcosm of large sectors of our domestic economy. Therefore, it would be very interesting to determine if an industry sector effect could be found in relation to the adoption of Mass Customization.

Since Mass Customization is so closely aligned with customers, it is argued here that textile industry sectors closer to the consumer will be thought of as more likely adopters of Mass Customization.

H1: Mass Customization will be perceived as more relevant as you move down the textile industry value chain towards the consumer.

3.2.2 HYPOTHESIS 2

The previous hypothesis held that there would be an industry effect. The next hypotheses bring the discussion down to business level. The contention at this level is that market choices and production methods will also influence perceptions of Mass Customization.

Although the word 'Mass' is prominently displayed in the name of the paradigm, it is felt that the word 'Customization' will dominate an individual's perception of the concept. The dominant perception will lead people to think of Mass Customization as specialized or novelty process and not as an alternative to the traditional approaches currently being practiced today. Mass Customization will not be perceived as seriously challenging the status quo. Given the anticipated reaction to this paradigm, it is contended that Mass Customization will be relegated to the status of a 'niche player' for quite some time in people's minds.

H2: Mass Customization will be perceived as more relevant to niche segments than to mass markets.

3.2.3 HYPOTHESIS 3

As stated earlier, modular manufacturing has been considered the approach of choice for Mass Customization. The idea of adding components (modules) to a standard chassis conjures up clear images of an assembly process. The textile industry has significant sectors (e.g., fiber producing and dyeing and finishing) that utilize a continuous process. These circumstances lead to the following assertion:

H3: Mass Customization will be perceived as more relevant for textile products that are assembled from discrete parts than from products resulting from a continuous process.

3.2.4 HYPOTHESIS 4

The underlying premise behind developing a strategy is that a set of coordinated actions will be more successful than a random set of actions. Strategy should influence firm behavior. In his classic book, *Strategy and Structure*, Chandler (1962) set the stage for two decades of research contending that the organizational structure and processes of an organization follow its strategy. It seems reasonable to assert that some strategies are fundamentally better aligned with Mass Customization than others. This is especially true for firms whose strategy is very customer-focused. Firms that are more cost and quality oriented may not immediately see Mass Customization as being relevant to their competitive circumstances. Therefore:

H4: Firms pursuing strategies that are more market-driven relative to their competitors are more likely to be positive towards Mass Customization than firms pursuing a more production-oriented strategy.

3.2.5 HYPOTHESIS 5

The previous hypotheses asserted that perceptions of Mass Customization would be influence by either industry or business level effects. However, before an organization adopts a new paradigm and breaks away from a long-established status quo, there will have to be someone who will be committed to changing the organization. Kanter (1983) referred to these people as "champions". Mass Customization will need its own "champions". The question isn't *if* Mass

Customization will need "champions -- the interesting questions is *who will these champions be*?

The final hypothesis contends that the most likely individuals to promote Mass Customization are either those who are closer to the customer or those whose job exposes them directly to changing market forces. These two factors lead to:

H5: Individuals with Corporate, Marketing, or Consulting responsibilities are more likely to be positive towards Mass Customization than individuals with production or engineering responsibilities.

3.3 CONCLUSION

This chapter developed the Enterprise Model of Mass Customization and followed the model with a series of testable propositions about the perceptions of Mass Customization within the textile industry. The next chapter will describe the methodology selected to verify the model and test the hypotheses.

CHAPTER FOUR:
RESEARCH METHODOLOGY

The previous three chapters described the theoretical basis for the present study. This chapter describes the research methodology chosen including a description of the sample, the data collection methods, and the variables used in this study.

4.1 SAMPLE

The proposed research can be divided into the two distinct sections of model development and hypothesis testing. Each section has it own sample, although there is some overlap. The reason for having two separate samples is quite simple -- the knowledge base of the subjects would not justify their inclusion in the other sample. Some individuals who are leading figures within the Mass Customization field are not involved in the textile industry and would have little to offer to the hypotheses section which is heavily weighted towards understanding how the textile industry perceives Mass Customization. Similarly, there are many individuals working within the textile industry that have an interest in Mass Customization but would not be considered, nor would they claim to be, experts in the Mass Customization field. It would not be appropriate to include these individuals in the model development section.

4.1.1 SAMPLE FOR MODEL DEVELOPMENT

The individual subjects for this phase shared a common knowledge of the Mass Customization field. This knowledge of Mass Customization has been demonstrated by published papers, presentations, organizing and leading corporate sessions, significant prior exposure, and consulting within this area. This screening process restricted the sample to those individuals who are leading contributors to the field. Their collective expertise allows them to provided a critical assessment of the Enterprise Model of Mass Customization. It was also anticipated that the mix of backgrounds, industry experiences, and organizational attachments would lead to rich and varied opinions from which to discover the appropriateness of the model.

4.1.2 SAMPLE FOR HYPOTHESES TESTING

The sample to test the hypotheses generated in Chapter Three was comprised of two groups. The first group was made up of those individuals described above for model development who are intimately involved with the textile industry. It would be wasteful not to capture their impressions given their combination of expertise and industry experience.

The second group consisted of individuals throughout the textile industry in managerial positions. (Note: It seemed inappropriate for the research questions being investigated in this project to use lower level employees. Once the model is verified and more firms adopt Mass Customization, future research that attempts to focus on

the individual linkages will certainly explore lower level phenomena. Other desired characteristics of the sample individuals included:

1) Individuals should come from firms in all sectors of the textile pipeline
2) Multiple individuals within the same firm
3) Individuals from a variety of functional backgrounds within the same company
4) A willingness to comply with the study

This sample was constructed through a variety of means. Textile firms that were identified in the literature and in the popular press as being associated with Mass Customization were contacted. Researchers at Auburn University kindly shared the names of companies and individuals who complied with Auburn's research effort on Mass Customization. In some cases, contacted individuals offered the names of other people who might be interested in the study. Finally, some individuals were contacted due to personal relationships and were asked if there were individuals within their firm with a knowledge of Mass Customization. This last tactic was useful when individuals from certain industry segments were needed. Regardless of how the individuals were discovered, all were made aware of Mass Customization through personal conversation with the researcher to ensure that everyone taking the survey understood the concept as it was being proposed in this study.

4.1.3 SAMPLE BIAS ISSUE

Whenever a sample is constructed with an aspect of "convenience" associated with it, a researcher needs to address concerns that the sample is biased and, thereby,

limits it generalizability (Stone, 1978). Admittedly, there was an element of convenience in the construction of both sample sets. In the model development set, only those individuals with expert credentials were considered. But since the role of this group is to assess the validity of the proposed model, limiting the sample to these individuals does not seem to overtly bias the findings.

However, the sample for testing the hypotheses can be called into question regarding sample bias. The response to this concern is three-fold. First, given the exploratory nature of this research and the limited amount of Mass Customization activity in the textile industry, it would be quite impossible to randomly select firms within the textile industry and expect to receive useful results. As Mass Customization emerges within the industry, a random sample design would, of course, be a reasonable and desirable sample selection option. Second, the collection of individuals resulted from many sources beyond personal contact with the researcher. Companies were contacted primarily because of an indication that they were associated with Mass Customization. These companies had no prior connection with the researcher. In most cases, the individuals completing the survey were selected by company officials and were unknown to the researcher prior to meeting with them. Third, it can be argued that any survey based on random sampling, but without 100% compliance, is a biased sample. Firms could decide to comply or not to comply for a variety of reasons besides randomness. There could certainly be strategic reasons not to comply which would, ultimately, bias the sample. Most survey researchers would

be overjoyed with a 10% compliance to a random sampling. What about the other 90% of the non-compliants? It is not being argued that that survey research based on a random mailing or selection should be curtailed because of potential bias but I am contending that it is inherently open to biases. The question is not *if* bias exists but rather its origination. In a traditional random design, the subjects inject the bias by deciding to comply or not. In the proposed research, the researcher may inject bias by selecting firms that meet certain requirements for the study. Either way, there is an element of bias which *could* creep into the research regardless of how the sample is constructed (short of 100% compliance or a sample that captures the complete universe of the sample). It is important to assert that there is no reason to suggest the companies and individuals in this study did accurately represent the textile industry.

4.2 DATA COLLECTION METHODS

Research methods are discussed separately for the model development phase and the hypotheses testing phase.

4.2.1 MODEL DEVELOPMENT INTERVIEWS

In order to assess the validity of the proposed Enterprise Model of Mass Customization, interviews were conducted with recognized experts within the field. During these semi-structured interviews, open-ended questions addressed the model's logic, linkages, completeness and viability. From these discussions it was hoped that

Face Validity and Construct Validity (Cook & Campbell, 1979) were established for the model. Some of the key issues that were focused on included:

1) model relevance;
2) need for additional elements or linkages;
3) need for subtraction of elements or linkages;
4) need for changes in element sequencing.

The semi-structured interviews began with a discussion of the Mass Customization concept to establish a common vocabulary and to better explain the purpose of the research. Next, the participants were shown the Enterprise Model of Mass Customization with an explanation of the elements and linkages. Comments and questions were noted. Finally, participants were asked to respond to specific questions that were then recorded for future analysis.

The raw data from the interviews were the responses by the subjects. This data was captured by contemporaneous note-taking or on audio tape (if allowed) by the participant.

4.2.2 HYPOTHESIS TESTING SURVEY

A questionnaire survey was constructed to test the hypotheses outlined in Chapter Three. The questionnaire attempted to capture both individual and corporate information. Regarding the individual, information concerning his/her demographics and views of Mass Customization within the textile industry were captured by the survey. Demographic information included functional background and current position. Most of the questions addressed the subjects' views on Mass Customization

within the textile industry with respect to marketing, production process, industry sector, and their own company. In addition, questions were asked to gain a temporal sense of when the participant perceived Mass Customization to emerge by asking the same question twice but altering the time horizon from 5 years to 10 years.

One of the research questions for this study concerned the role of corporate strategy in adopting Mass Customization. Therefore, it was important to capture corporate level data such as strategy, size, and position within the textile complex. In order to minimize confusion for individuals who were part of larger multi-divisional firms or vertically integrated firms, the participants were asked very early to select only one business segment to consider while completing the survey. To reinforce this mindset, the participants were asked to write their strategic business unit (SBU) on the survey form

At the end of the survey, the participants was asked for any final comments and thanked for their participation. The individual surveys were compiled, coded and analyzed appropriately. A complete survey can be found in Appendix A.

4.3 VARIABLES

There are a number of variables that must be captured by the survey instrument to properly test the hypotheses. This section will explain how these variables were captured and operationalized for the research. First, the dependent variable is discussed and, then, the independent variables are outlined. The independent variables

are further divided into three categories: (1) industry level variables, (2) corporate level variables, and (3) individual level variables.

4.3.1 DEPENDENT VARIABLE: PERCEPTION OF MASS CUSTOMIZATION

The purpose of the questionnaire was to determine how industry participants perceive the applicability of Mass Customization to the textile industry. The research design choice came down to whether to directly ask the subjects to give their response to such a question on a 9-point scale or to construct a composite measure to capture perceptions more obliquely. Since Mass Customization is a new concept within this and other industries, it was felt that a direct measure might be excessively influenced by the research itself. If someone asked you about the latest trend, you are likely to be very influenced to give confirmation about that trend. To minimize this potential source of bias, it was decided to ask the subjects to respond to a series of questions designed to elicit responses about a specific sector of the industry (see Appendix A for the questionnaire and Part III for the questions which provided the data for the dependent variable calculation). By instructing the subjects to consider a specific industry sector, the applicability of Mass Customization was grounded on a concrete reference point.

There was also a concern raised about the timing of the adoption of Mass Customization and how that might skew the results. Perhaps an individual believed that Mass Customization will be viable but not in the near future. What is the *near*

future and isn't it likely that different individuals would have different definition of time. To counteract this problem, two questionnaires exactly alike except for a 5-year timespan in the first and a 10-year timespan in the second were administered for each sector. Statistical testing was performed to determine if there was a time dependent element to the perception of Mass Customization's adoption.

4.3.2 INDEPENDENT VARIABLES: INDUSTRY LEVEL

The industry level variables were industry pipeline sectors. Each participant selected from among:

Fiber producer;
Yarn producer;
Fabric Forming;
Dyeing & Finishing;
End-Use Apparel;
End-Use Other.

The influence of industry characteristics has been an important issue in both economics and business literatures. The sub-field of economics known as Industrial Organizational (IO) economics has studied industry structure for many years (Scherer, 1980). In fact, IO economics is responsible for most of the basis for the field of Strategic Management (Porter, 1980; Hofer & Schendel, 1978; Mintzberg, 1994). Although this study is limited to one industry, it is composed of a number of segments that are in many ways quite different. Research in an area referred to as "Strategic Group" has shown the importance of understanding the industry structural dynamics at a deeper level of analysis (Cool & Dierick, 1993; Reger & Huff, 1993). Given the

rich literature on industry structure, it was important to capture this dimension within this study on the textile industry.

4.3.3 INDEPENDENT VARIABLES: CORPORATE LEVEL

Corporate level variables focus on information regarding the participant's company. These included descriptive variables such as:

Corporate Size	-- measured in the number of employees;
Position in Textile Pipeline	-- see "Industry Level Variables" above;
Production Process	-- measured by choosing either "Continuous Process" or "Component Assembly Process";
Company Strategy	-- measured by choosing among three strategic scenarios: "Operational Excellence" "Product Leadership" "Customer Intimacy".

The size of the organization was captured since size had long been linked to a number of organizational issues (Fredrickson & Iaquinto, 1989; Lorange & Vancil, 1976; Mintzberg, 1973). Increases in size often force firms to deal with additional organizational complexity. As a means to adjust to this higher level of complexity, firms may turn to more formalized structures (Thompson, 1976; Quinn, 1980; Quinn & Cameron, 1983). It has been found that undesired consequence of this new structural form is often a progressively stronger resistance to fundamental change (Tushman & Romanelli, 1985). Given that it has been argued throughout this study that Mass Customization is a fundamentally new paradigm, it was useful to capture firm size in a study on the topic.

A number of viable proxies can be used to measure firm size. Some are financial in nature, such as revenue, profit, and assets. Others are organizationally based such as number of employees or market position. Since the current study focuses on an industry that has both a fair number of privately-held firms and is noted for being somewhat secretive about financial figures, it was decided to capture firm size as a reflection of the number of employees. Most companies are relatively open regarding this type of data.

The position within the textile industry is somewhat straightforward except for firms that are vertically integrated along some means. In those cases, the subject was asked to select either the stage of the pipeline with which he/she is most familiar or the stage to which the firm is most committed.

One of the interesting unanswered questions within the Mass Customization community is whether Mass Customization is primarily aimed at component assembly operations. In order to customize individual products on a mass scale, it is generally thought that the process must be amenable to modularization (Pine, 1993a; Kotha, 1995). Even when service operations are considered, the process is typically either modularized by service (e.g., insurance policies) or by computer integration. One of the primary objectives of this study involved the subjects' perception of what type of production process was best suited for Mass Customization. It was, therefore, appropriate to determine the process that the subjects were using in their organizations.

This information was gathered by self-report after a brief explanation of both types of processes.

The classification of strategy type is sensitive to industry differences (Hambrick, 1983). The validity of this variable was enhanced for two reasons. First, the concern regarding industry differences was lessened as all participants were from the same industry. Second, the participants selected from among three scenarios to provide some context for their decision.

The three strategic scenarios for company strategy were based on a typology developed by Treacy and Wiersema (1995). This typology was chosen over other potential strategic typologies such as Porter's (1980) *Low Cost Producer, Differentiation, and Focus* or Miles & Snow's (1978) *Defender, Prospector, Analyzer, and Reactor* for several reasons. First, each of the three scenarios by Treacy and Wiersema have a positive connotation associated with a company pursuing that strategy. This may not have been the case for Porter's Low Cost Producer which many firms may actually have been pursuing but given the recent environment of TQM and "customer focused" mission statements, many participants may have had difficulty acknowledging this as their strategy. This concern was doubly important since many textile firms have traditionally followed this strategy. The option of characterizing one's firm as pursuing "Operational Excellence" may have been much more appealing. The Miles & Snow's (1978) terminology does not lend itself to obvious interpretation and, therefore, may have lead to confusion and indecision.

The second reason for the choice of this particular typology was that it enabled one to easily collapse "Product Leadership" and "Customer Intimacy" into one category for hypothesis testing. These two categories were converted to "Market Driven Strategies" while "Operational Excellence" formed the basis for the "Production Oriented Strategies". Since the sample size was limited, it was important not to divide it into too many categories for statistical reasons.

In addition, Porter's "Focus" strategy is actually two strategies -- one strategy that pursues a targeted market segment using a "Focus - Low Cost" strategy while another Focus strategy concentrates on an upper-end market using a "Focus - Differentiation" strategy. It may have been difficult for some firms to accurately classify their strategy as "Differentiation" versus "Focus-Differentiation" and any confusion may have skewed the results. There is some debate within the strategic management field as to exactly when a strategy stops being is an industry-wide strategy ("Low Cost Producer" or "Differentiation") and becomes a "Focus" strategy. Since the current study had little need for such fineness in distinction, it was decided not to attempt to develop a measure along these lines.

4.3.4 INDEPENDENT VARIABLES: INDIVIDUAL LEVEL

Both individual level variables, "Current Position" and "Functional Background", attempted to capture the personal and organizational biases that may

have crept into how an individual perceives Mass Customization within his/her industry and, also, his/her company. These variables were captured by:

Current Position -- measured by self-report;
Functional Background -- measured by choosing from:
- Manufacturing
- Engineering
- Research & Development
- Marketing
- Sales
- Finance / Accounting
- Other (please specify).

Individuals explicitly and implicitly use various filters as means to make sense out of incoming information. How managers make decisions has been a long debated and heavily researched topic (Walsh, 1988). However, one filter that appears to have reached a consensus as an important contributor to decision-making is the individual's functional background (Hambrick & Mason, 1984; D'Aveni, 1989). This stream of research concludes that most managers have finite repertoires that are primarily grounded from their experiences and functional background. It is argued that firms select managerial resources based on their ability to cope with the critical resource dependency facing the firm at that moment (Pfeffer & Salancik, 1978). While this may be prudent and profitable in a stable environment, there are inherent problems for firms in turbulent times.

In order to take advantage of change and to adapt to a changing environment, organizations must first recognize the signs that a change is eminent. It has been shown that the ability to scan the environment is limited by one's background

(Aguilar, 1967; Dearborn & Simon, 1958). As outlined in Chapter 2, the Mass Customization paradigm is driven by significant external forces that are fundamentally changing the competitive landscape. Hayes & Abernathy (1983) predicted the problems experienced by many firms over the past decade by primarily pointing to the make-up of the top management teams as being predisposed to ignore change.

Several researchers (Hambrick & Mason, 1984; D'Aveni, 1989) have called for greater use of demographic variables in organizational research. The advantages often cited include objectivity, parsimony, and possible replication. While not perfect proxies, functional background variables do provide a lens from which to glimpse at managerial decision-making.

When testing the hypotheses, the responses from the "Functional Background" self-report were collapsed into two categories -- 1) individuals with a corporate or external focus (i.e., Marketing, Sales, Top Management, Consultants, and Finance/Accounting), and 2) individuals with responsibilities for operations and production or an internal focus (i.e., Manufacturing, Engineering, and Research & Development). The reason for this decision was to allow for more robust statistical results.

4.4 STATISTICAL ANALYSIS

Statistical analysis that provides accurate and reliable testing was used. The statistical analysis section is divided into the two areas of questionnaire validity and statistical methods.

Content validity determines the adequacy of the sample domain to describe the measure (Stone, 1978). Face validity determines the apparent applicability and appropriateness of the methods. The questionnaire constructed for this study was adapted from existing research on Mass Customization (Pine, 1993a) and other scales in the management literature. As a precaution the questionnaire was sent to leading experts in the field of Mass Customization and business researchers for suggestions. Minor modifications were made as a result of this process. In addition, the questionnaire was pilot tested in a local firm subsequent to primary data collection. As a final check, most participants completed the questionnaire in the presence of the researcher so any confusion regarding a question could be clarified immediately.

The hypotheses generated and discussed in Chapter 3 were tested using appropriate statistical procedures. These statistical techniques include the Student's T-Test (used for Hypothesis 2: Niche versus Mass Markets; Hypothesis 3: Continuous versus Assembly Production Process; Hypothesis 4: Strategic Type; Hypothesis 5: Functional Background), ANOVA (Hypothesis 1: Position in Textile Pipeline), and Multiple Regression, Step-wise Regression, and 2-way ANOVA.

The Student T-Test compares the sample means and determines if the two means are significantly different. There are three assumptions that must be met for this test: 1) the observations are independent; 2) the observations for each group are a sample from a population with a normal distribution; and 3) the variances of the two independent groups are equal (Schlotzhauer and Littell, 1987). In this study, this technique was used to compare the perceptions of industry subjects to the application of Mass Customization to their industry.

An ANOVA is similar to a T-Test except that more than two group means are being compared. Hypothesis 1 asserted that Mass Customization would be perceived as more applicable as the pipeline got closer to the ultimate consumer. An explicit contention from this hypothesis was that the means from each industry sector would be different. This contention was explored by a basic 1-way ANOVA. There are three assumptions that must be met to use ANOVA: 1) the observations are independent; 2) the observations are sampled from a normal distribution; and 3) the groups have equal variances (Schlotzhauer & Littell, 1987).

Finally, Multiple Regression is a statistical technique that allows for determining relationships among a number of independent variables with the dependent variable simultaneously. The intent is to explain the variability of the independent variables to see whether and how much each independent variable contributes to explaining the hypothesized relationship. A variation of Multiple Regression was used called "Stepwise Regression" to get a better sense of the strength

of the relationships. The primary assumptions underlying regression analysis are: 1) the observations must be independent; 2) there is homogeneity of variance; 3) the dependent variable should be normally distributed; and 4) linearity between independent and dependent variables (Hatcher & Stepanski, 1994). In this study, Multiple Regression was used to see which set of the independent variables outlined above contributed to one's understanding of how individuals within the textile industry perceive Mass Customization.

4.5 LIMITS TO GENERALIZABILITY

Caution should be used in generalizing the results of this study as it is based on a single industry -- the textile industry. Views could be biased by industry-specific perspectives, experiences, and background. However, the textile industry is a very broad industry, encompassing highly scientific sectors such as fiber production and very market driven sectors such as apparel. In addition, the textile industry experienced global competition earlier than many other industries and, thus, may be an interesting industry to view as a model for other industries.

CHAPTER FIVE:
RESEARCH RESULTS

This chapter presents the results of the research outlined in the previous chapter. The research results are broken into two sections relating to the research hypothesis questions and the model development for Mass Customization.

A discussion regarding the characteristics of the sample is presented prior to the results of the hypothesis testing. The remainder of this section of the chapter is devoted to presenting the results of testing each specific hypothesis and an analysis of the findings. The questionnaire which served as the data collection instrument for this study can be found in Appendix A. A quick assessment of the instrument would reveal that Parts 1, 2, 3, 4, and 5 capture the data needed to test the research hypotheses. Parts 6 and 7 provide additional information that can be used to better understanding the responses to the hypotheses questions as well as to provide insight and potential data for additional questions in future research efforts.

The second section of this chapter focuses on the results of the interviews with noted experts on Mass Customization and, also, discussions with individuals within the textile community who are intimately familiar with Mass Customization. Their comments were noted and incorporated into the revised Enterprise Model of Mass Customization. A thorough description and discussion of this revised model follows. The development of this model is a primary goal of this entire research project.

5.1 RESULTS OF HYPOTHESES TESTING

The following sections address the sample and data that resulted from the combination of field research and the administration of the research questionnaire. First, a general overview of how the sample was actually developed is outlined. Next, the sample is described along various dimensions to give a sense of the subjects and their firms so as to give context to the research undertaken.

The discussion of the sample is followed by the statistical results from testing the hypotheses outlined in Chapter Three. Each hypothesis will be addressed separately in its own section. This section of Chapter Five concludes with a summary segment integrating all the findings.

5.1.1 SAMPLE CHARACTERISTICS

Sixty-six (66) participants from a total of twenty-five (25) firms within the textile industry agreed to serve as subjects for this research study. Upon contacting each firm, a guarantee of anonymity was granted as a means to secure participation. It was very important, in order to test the hypotheses, that access to individuals of various backgrounds from companies representing all sectors of the industry was achieved. It was also hoped that these firms would not be overwhelmingly pursuing similar business strategies. Fortunately, these objectives were met.

While it was hoped that multiple individuals from a particular firm would participate in order to achieve multiple viewpoints, four companies were represented by only one individual. Multiple attempts to rectify this situation proved unsuccessful.

The process used to secure the data can be classified into 3 categories: Face-to-Face interview, Telephone Interview, Fax/Mail. The Face-to-Face interview was used in collecting 54 of the 66 subjects (81.8%). A Telephone Interview was used in 5 cases (7.6%), while the Fax/Mail technique was used for the remaining 7 participants (10.6%). Table 5.1 depicts the proportional use of the three methods. It may be instructive to explain each process in some detail.

The primary vehicle used for data collection was overwhelmingly Face-to-Face interviews. These interviews took place in the states of North Carolina, South Carolina, and Georgia. A typical interview began with a phone call to an individual within the firm requesting participation. If the person was agreeable, it was inquired if others might also be persuaded to participate. At this time, the specific individual characteristics that were being sought for the sample (e.g., functional background, director / vice-president or above level) were discussed. A meeting time of approximately one hour was scheduled after a series of phone calls. Following the introductions, the meetings began with a 15-20 minute presentation by the researcher on the topic of Mass Customization. The purpose of the presentation was to clarify terms and assure that all participants had at least the same base level of understanding. It was felt that such an exchange would improve the likelihood of receiving informed

responses. In over 90% of the Face-to-Face interviews, the questionnaire was completed at the end of the presentation. The researcher literally walked the group through the different sections of the instrument. However, the participants were requested not to discuss their answers or view each other's responses until after the entire instrument was completed. Participant compliance on this request was 100%. The participants were thanked for their cooperation and time.

When the Face-to-Face interview proved to be too difficult or too expensive to arrange, one of the two other methods was applied. In both cases, individual participants received a lengthly letter describing Mass Customization subsequent to completing the survey. If the telephone method was used, the early portions of the call consisted of an abbreviated version of the presentation that was given in the Face-to-Face interviews. Again, the objective was to ground the participant in Mass Customization.

TABLE 5.1

SURVEY ADMINISTRATION TECHNIQUES

	NUMBER	***PERCENTAGE***
FACE-TO-FACE	***54***	***81.8 %***
TELEPHONE	***5***	***7.6***
MAIL / FAX	***7***	***10.6***
TOTAL	**66**	**100 %**

5.1.1.1 SAMPLE CHARACTERISTIC: CORPORATE SIZE

Since the purpose of the research was to determine how individuals within the textile industry perceive Mass Customization, it wasis important to understand the context in which their perception was grounded. One possible influential factor might have beeen the corporate context in which the individual participates. Therefore, it was decided to capture the size of their company. Given the private nature of the textile industry, it was decided that "number of employees" would be a proxy that would not only give an appropriate measure of the corporate context but also a proxy that companies were not overly reluctant to offer (as opposed to "Sales" or "Profits").

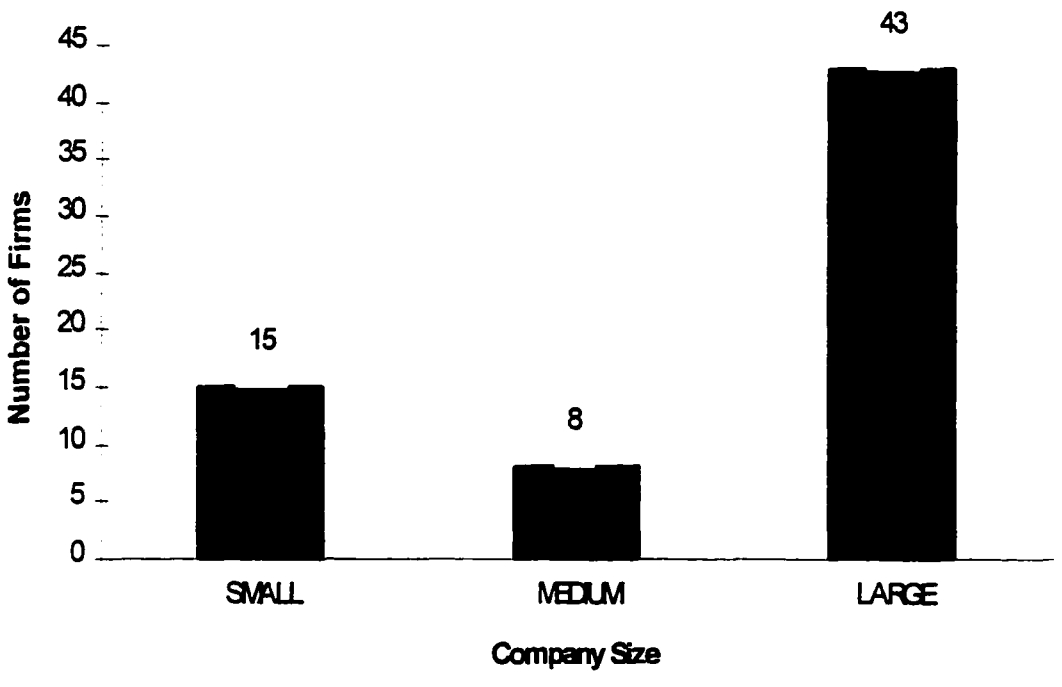
As indicated in Chapter Three, the corporate size variable was segmented into 3 segments -- Large, Medium, and Small. A firm was designated as being "Large" if it employed over 3000 people. A "Medium" sized firm designation was attached to those firms employing between 1000 and 2999 employees. Finally, firms employing less than 1000 employees were placed into the "Small" category.

The size of the firms in the sample ranged from approximately 70 employees to over 100,000 employees within the corporate structure. Figure 12 depicts the distribution of the sample along the size category designations.

Upon first review, this may seem to be a skewed sample of the industry as there are many more small textile firms than there are large firms employing over 3000 people. On purely the basis of number of firms within these categories it may seem that the individuals who responded to this research sample were not

representative of the industry. However, a persuasive argument could certainly be made that this sample probably represented the industry context much better than one based solely on the number of firms in different size categories. The research sample was much closer to the industry sales distribution where large firms dominate most sectors of the industry as well as overall industry sales.

FIGURE 13



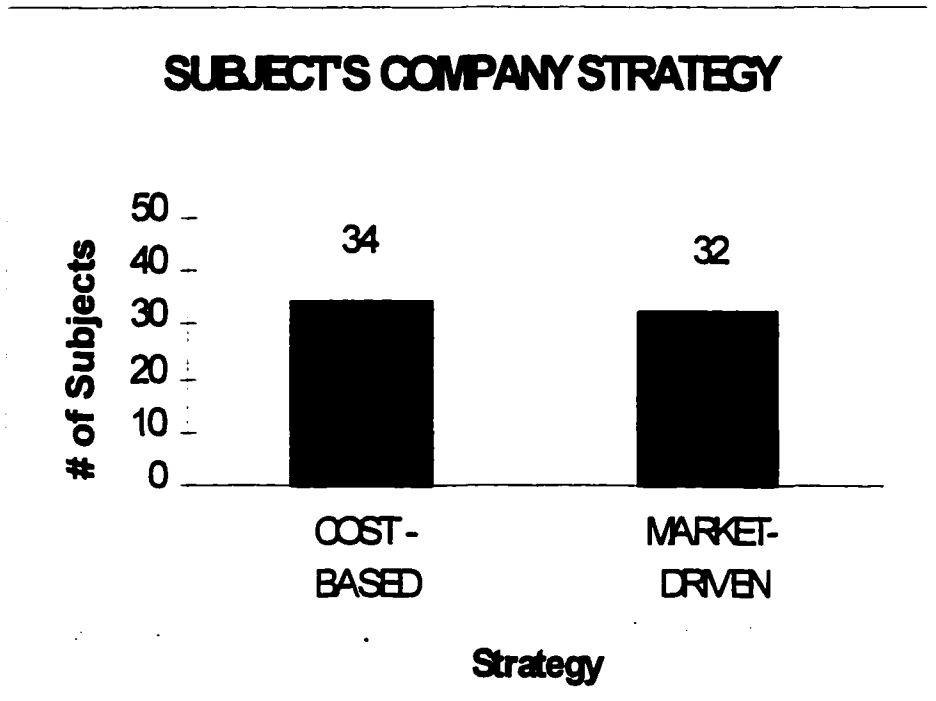
5.1.1.2 SAMPLE CHARACTERISTIC: FIRM STRATEGY

A second characteristic that might have been influenced how individuals within the industry view Mass Customization was the strategy that their company was pursuing. Strategies often provide the lens from which companies, and those in the company, view industry forces. Since, as was discussed in Chapter 2, Mass Customization is a relatively new paradigm with a substantially different orientation from previous paradigms, it is possible that certain corporate strategies may color individual perspectives.

The strategy being pursued by the participant's firm was captured by asking the subject to select from among three scenarios the one that best exemplified their firm (see Appendix A for the scenarios). The study, however, was not concerned with delineating that finely so the three potential responses were collapsed into the two categories of "Marketing-oriented Strategy" and "Production-oriented Strategy".

As Figure 13 reveals, the participants were practically evenly split among the two categories of firm strategy. It is difficult to determine the representativeness of this response relative to the industry as a whole as such information is not readily available nor systematically captured from any source known to the researcher of this study.

FIGURE 14

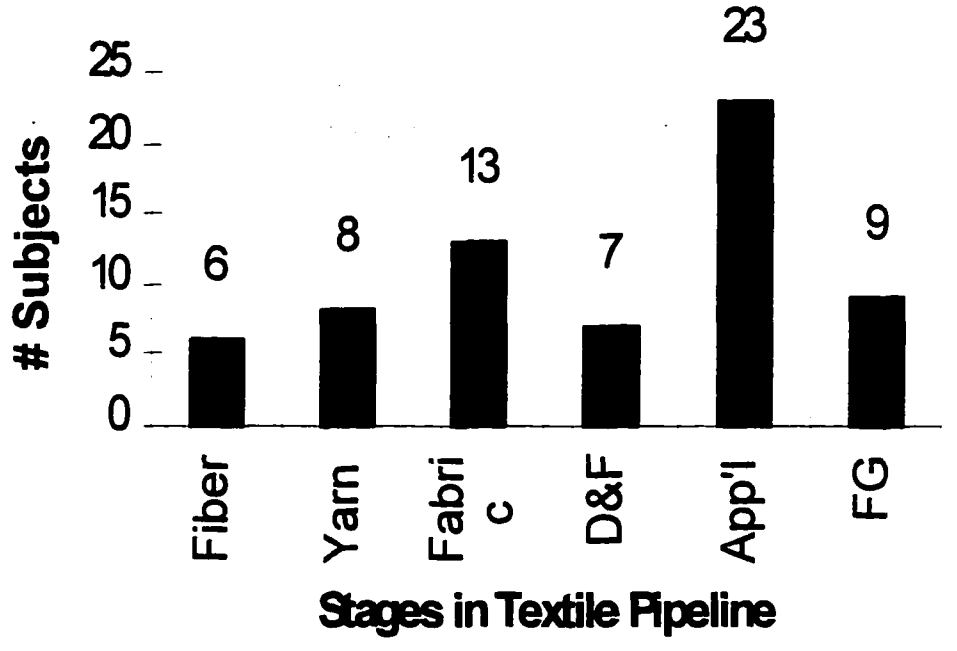


5.1.1.3 SAMPLE CHARACTERISTIC: POSITION IN TEXTILE PIPELINE

A primary objective of this study was to view Mass Customization from the perspective of the entire industry. Therefore, it was imperative that the participants came from companies representing a good cross-section of the textile industry. As Figure 14 indicates, the participants work throughout the textile complex and

somewhat mimic the proportion of firm representation through the various sectors of the industry -- fiber, yarn, fabric, dyeing & finishing, apparel, and other finish goods.

FIGURE 15

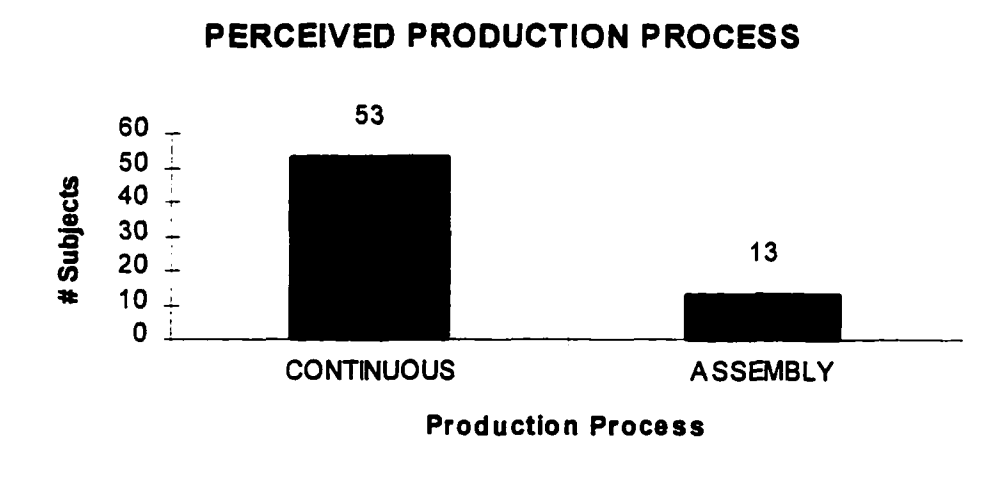


5.1.1.4 SAMPLE CHARACTERISTIC: PRODUCTION PROCESS

In Chapter Three it was hypothesized that Mass Customization would be perceived by those in the textile industry as being more applicable to a production process characterized as an assembly of component parts than for a continuous process operation. Since the study dealt with perceptions, how an individual responded to a question regarding the production process might have been influenced by the process with which he/she was most familiar. The self-report data from participants regarding the production process in their firm was captured for just the reason described above.

Over 80% of the participants reported that their company was using a continuous process (Figure 15). This finding is consistent with an industry where much of the industry (i.e., fiber production, yarn spinning, fabric formation, and dyeing & finishing) is dominated by what many may refer to as a continuous process.

FIGURE 16

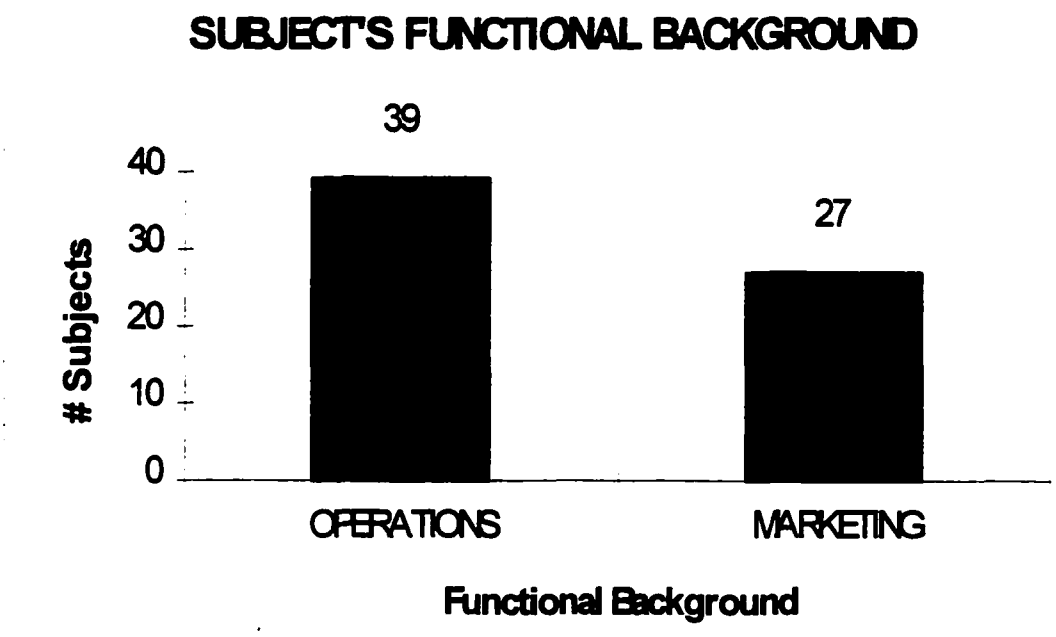


5.1.1.5 SAMPLE CHARACTERISTIC: FUNCTIONAL BACKGROUND

The previous characteristics focus on the context that the participant experiences because of the type of firm he/she happens to work for within the industry. It is also important to consider the personal background of a person and how those experiences may alter he/she perspective. It has been shown in studies in many areas that functional background influences informational processing ability, perception, and judgment (Dearborn and Simon, 1958; Hambrick and Mason, 1982; Kefalas and Schoderbek, 1973; D'Aveni, 1989).

As can be seen in Figure 16, the participants in this study were more prone to come from the production or operations side of the business. A full 60 percent of the respondents classified themselves as an "Operations" individual. This was not unexpected given the nature of the textile industry that has historically emphasized the areas of cost containment and efficiency. It would not be surprising to find in a study comparing marketing individuals from the textile industry with marketing personnel from other industries that those in textile are more production focused. What was important for this study was that there were a healthy number from both functional disciplines represented and the proportion of each discipline was acceptable for statistical purposes.

FIGURE 17



5.1.2 HYPOTHESES TESTING

The sample described above was responsible for the data necessary to test the research hypotheses outlined in Chapter 3. In that chapter, the hypotheses regarding the perception of Mass Customization in the textile industry are presented in a hierarchical alignment reflecting industry, organizational, and individual contexts. The following sections address the findings that resulted from the hypothesis testing. These findings will be presented first from the industry level, then the organizational level and, finally, the individual level.

5.1.2.1 Hypothesis 1

H1: Mass Customization will be perceived as more relevant as you move down the textile industry value chain towards the consumer.

The hypothesis was supported for both the 5-year timeframe and the 10-year timeframe. Results were analyzed using a one-way ANOVA, between-groups design. This analysis revealed a significant effect ($p < .001$) for the position within the textile industry pipeline for both time periods. The sample means are displayed in Figure 17 for the 5-year timeframe and Figure 18 for the 10-year timeframe.

FIGURE 18

Means of Position in the Textile Pipeline

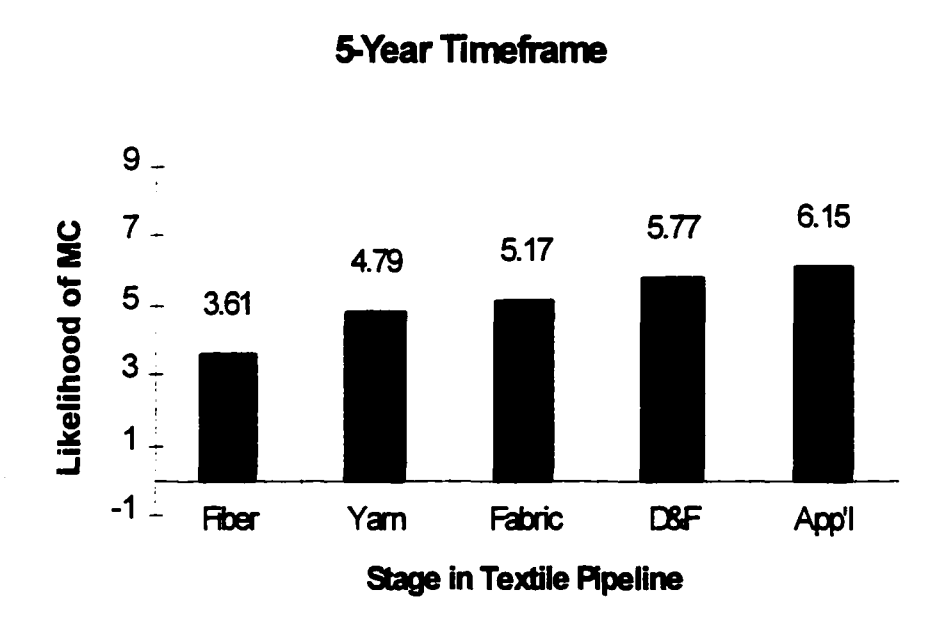
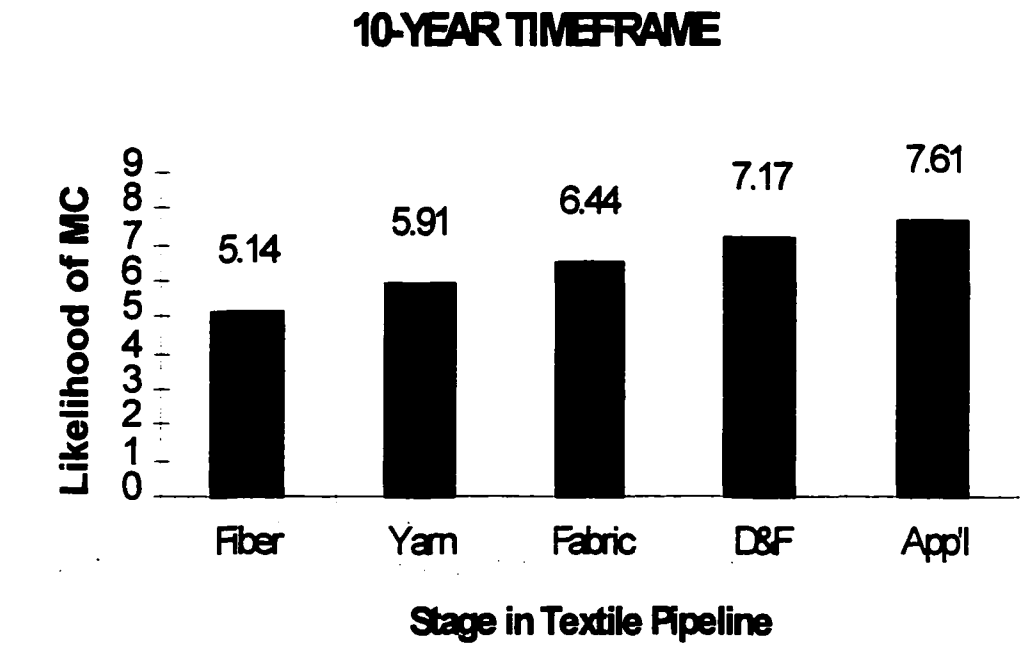


FIGURE 19

Means of Position in the Textile Pipeline



The statistical results for this hypothesis are summarized in Table 5.2 for the 5-year timeframe and Table 5.3 for the 10-year timeframe. These results indicate that the participants felt that Mass Customization is not uniformly applicable across the textile industry.

TABLE 5.2

ANOVA Results for Pipeline Position: 5-Year Timeframe

SOURCE	DF	SS	F	Significance Level
Pipeline Position	4	256.87	26.82	$p < .001$
Within Group	325	778.03		
Total	329	1034.90		

TABLE 5.3

ANOVA Results for Pipeline Position: 10-Year Timeframe

SOURCE	DF	SS	F	Significance Level
Pipeline Position	4	255.32	27.87	$p < .001$
Within Group	325	744.41		
Total	329	999.72		

While the results indicate that the sectors of the industry are not all perceived as equally hospitable to Mass Customization, the One-Way ANOVA does not indicate

which sectors are significantly different from another. To determine this information, a Tukey's HSD test was performed. A Tukey's HSD test allows for multiple comparisons to be made among treatment effects.

The results of the Tukey's HSD applied to the 5-year timeframe revealed that there are three groups of distinct industry sectors. The means for the Apparel and the Dyeing & Finishing sectors are significantly higher than all the other sectors. The Fabric and Yarn sectors are significantly lower than the Apparel and Dyeing & Finishing but significantly higher than the Fiber sector. Finally, the Fiber sector is significantly lower than all the other sectors. The breakdown looks like this:

Highest Group: Apparel and Dyeing & Finishing;
Middle Group: Fabric and Yarn;
Lowest Group: Fiber.

The results for the 10-year timeframe are very similar except that the Fabric and Yarn sectors have split and are now significantly different. In this case, there are four groups that are significantly different. Apparel and Dyeing & Finishing remained indistinguishable with respect to mean scores. The breakdown:

Highest Group: Apparel and Dyeing & Finishing;
2nd Group: Fabric;
3rd Group: Yarn;
4th Group: Fiber.

These results mimic the textile pipeline and provide further support to the hypothesis under investigation. Not only do the participants perceive the opportunities for Mass Customization as being unequal across the industry but they also agree with the hypothesis that the better sites for application may be in those sectors closest to the

consumer. An implication of this findings is that Mass Customization will probably be investigated and adopted by those firms which lie closest to the consumer. These firms will have to make the key strategic decisions regarding the application of Mass Customization without the benefit of history. A different implication of this result is that firms somewhat removed from the ultimate consumer may become complacent regarding progress along Mass Customization dimensions and miss a significant opportunity to shape their future rather than react to events.

5.1.2.2 Hypothesis 2

H2: Mass Customization will be perceived as more relevant to niche segments than to mass segments.

The hypothesis was supported in both the 5-year timeframe and the 10-year timeframe. The results were analyzed using an independent-sample T-test. This analysis revealed a significant difference between the two groups. The participants perceived that Mass Customization was more likely to be applied to niche markets than to mass markets. This perception holds for the near term (5 years) and for the longer term (10 years). The statistical results for this hypothesis are summarized in Table 5.4 and Table 5.5.

The variances can be considered equal as the Prob>F' = 0.5636 for the 5-year timeframe. In comparing the results of the 5-year timeframe, it has a t-statistic value of $p < .0001$.

However, in the 10-year timeframe the variances cannot be considered equal as the Prob>F' = 0.0334. Therefore, the "unequal" variance calculation is appropriate. In this case, the results are still significant with a t-statistic value of $p < .0001$.

TABLE 5.4

Results of a T-test Comparing Market Type Perceptions: 5-Year Timeframe

Market Type	Mean	Std. Dev.	Significance Level
Mass Market	3.909	1.58	<.0001
Niche Market	6.182	1.47	

TABLE 5.5

Results of a T-test Comparing Market Type Perceptions: 10-Year Timeframe

Market Type	Mean	Std. Dev.	Significance Level
Mass Market	5.288	1.62	<.0001
Niche Market	7.667	1.24	

5.1.2.3 Hypothesis 3

H3: Mass Customization will be perceived as more relevant for textile products that are assembled from discrete parts than for products resulting from a continuous process.

The hypothesis was supported. The results were analyzed using an independent-sample T-test. This analysis revealed a significant difference between the two groups. The participants appear to view Mass Customization as being more applicable for a production process that is geared towards the assembly of component parts than for a continuous process. The statistical results for this hypothesis are summarized in Table 5.6.

TABLE 5.6

The Results of a T-test Comparing Production Processes

Production Type	Mean	Std. Dev.	Significance Level
Assembly	6.742	1.47	$p < .0001$
Continuous	4.091	1.69	

5.1.2.4 Hypothesis 4

H4: Firms pursuing strategies that are more market-driven relative to their competitors are more likely to be positive towards Mass Customization than firms pursuing a more production-oriented strategy.

The hypothesis was supported in the 5-year timeframe and the 10-year timeframe. The results were analyzed using an independent-sample T-test. The analysis revealed a significant difference between the two groups. It appears that individuals within the textile industry are influenced by their own firm's strategy regarding their perception of the applicability of Mass Customization within the industry. The statistical results for this hypothesis are summarized in Table 5.7 and Table 5.8.

TABLE 5.7

Results of a T-test Comparing the Influence of Strategy: 5-Year Timeframe

Strategy Type	Mean	Std. Dev.	Significance Level
Operations	4.887	1.17	$p < .01$
Market	5.568	0.72	

TABLE 5.8 Results of a T-test Comparing the Influence of Strategy: 10-Year Timeframe			
Strategy Type	**Mean**	**Std. Dev.**	**Significance Level**
Operations	6.230	1.13	p <.01
Market	6.864	0.75	

5.1.2.5 Hypothesis 5

Individuals with Corporate, Marketing, or Consulting responsibilities are more likely to be positive towards Mass Customization than individuals with production or engineering responsibilities.

The hypothesis was supported in both the 5-year timeframe and the 10-year timeframe. The results were analyzed using an independent-sample T-test. This analysis revealed a significant difference between the two groups. Individuals with marketing-related backgrounds appear to recognize Mass Customization as an opportunity more than those textile industry individuals with operations-related backgrounds. The statistical results for this hypothesis are summarized in Table 5.9 and Table 5.10.

TABLE 5.9

Results of a T-test Comparing Individual Background: 5-year Timeframe

Background	Mean	Std. Dev.	Significance Level
Operations	4.795	0.99	p <.001
Marketing	5.827	0.73	

TABLE 5.10

Results of a T-test Comparing Individual Background: 10-year Timeframe

Background	Mean	Std. Dev.	Significance Level
Operations	6.103	0.95	p <.001
Marketing	7.167	0.73	

5.1.2.6 SUMMARY OF HYPOTHESES TESTING

The results of testing the hypotheses are shown in Table 5.10. The results are summarized as to whether each hypothesis was supported or not supported following the analysis of the statistical testing. Fortunately, all the hypotheses that were tested were supported at high levels of probability.

The next section will report on a number of additional tests that were run in an effort to gain a deeper understanding of the dynamics of Mass Customization within the textile industry.

TABLE 5.11

Summary Results of Hypotheses Testing

HYPOTHESIS	RESULT
H1: *Mass Customization will be perceived as more relevant as one moves down the textile industry value chain towards the consumer.*	***SUPPORTED*** ***p <0.001***
H2: *Mass Customization will be perceived as more relevant to niche segments than to mass segments.*	***SUPPORTED*** ***p <0.001***
H3: *Mass Customization will be perceived as more relevant for textile products that are assembled from discrete parts than for products resulting from a continuous process.*	***SUPPORTED*** ***p <0.001***
H4: *Firms pursuing strategies that are more market-driven relative to their competitors are more likely to be positive towards Mass Customization than firms pursuing a more production-oriented strategy.*	***SUPPORTED*** ***p<0.001***
H5: *Individuals with Corporate, Marketing, or Consulting responsibilities are more likely to be positive towards Mass Customization than individuals with production or engineering responsibilities*	***SUPPORTED*** ***p<0.001***

5.1.3 ADDITIONAL TESTING RESULTS

In addition to the tests performed to test the hypotheses generated in Chapter 3, several other tests were performed to determine other facets about how Mass Customization is perceived within this industry.

Although there was little basis to formally hypothesize when the adoption of Mass Customization would occur in the textile industry, it would be interesting to check if the participants perceived a temporal component to this adoption. Therefore, a test was run to determine if the perception of Mass Customization was different in the 5-year timeframe than in the 10-year timeframe. An independent-sample T-test was administered and the results revealed a significant difference. The sample means (5.212 versus 6.538 for the 5-year and 10-year timeframes, respectively) are significantly different with a T-statistic value of $p < .001$. It appears that these participants believe that Mass Customization will be adopted gradually over the next decade.

A second question that begged to be investigated involved the influence that organizational size would have on the adoption of Mass Customization. Whether large firms or small firms would be the first to adopt Mass Customization techniques is a debatable question. One could argue that the potentially significant investment in technology as well as the sophistication would give the larger firms an advantage. However, one could equally argue that the smaller firms are more likely to adapt to new opportunities and, thus, would be more likely to adopt Mass Customization.

Again, an independent-sample T-test was administered to test which size of company was perceived by the participants as to be more likely to first adopt this paradigm. The results were statistically significant ($p < .001$) in favor of the smaller firms. In fact, the differences on this question were among the largest in the study (Large firms mean = 3.924 versus Small firms mean = 6.59).

Finally, it was thought that determining which demographic or organizational factors were most prominent in influencing how an individual perceives Mass Customization would be of significant interest. A "Stepwise Regression" statistical technique was employed to look at these variables for both the 5-year and 10-year timeframes (Table 5.12 and Table 5.13).

A Correlation Analysis revealed high correlations between Strategy and Production Process (0.6718) and between the Size of the Company and its Position in the Textile Pipeline. Neither of these results is surprising given the nature of the industry. It has long been prescribed by strategic management theorists (Chandler, 1962) that organizational structure should support the organizational strategy ("Structure follows Strategy"). So it should follow that the production process being pursued should complement the strategy.

It is also widely known in the textile industry that the early stages in the textile pipeline are dominated by a few large firms. It is also well-known that the apparel sector is very fragmented and contains a significant proportion of smaller firms.

TABLE 5.12

STEPWISE REGRESSION: 5-Year Timeframe

VARIABLE	PARTIAL R^2	MODEL R^2	F	Significance Level
Background	0.2484	0.2484	21.1522	p<.0001
Strategy	0.0768	0.3252	7.1745	p<.0094
Size	0.0261	0.3513	2.4943	p<.1193

With the criteria for inclusion set at 0.15 three variables (Functional Background, Company Strategy, and Organizational Size) comprise the "best" model for determining the likelihood of adopting Mass Customization. Only Functional Background and Strategy are loaded at a more traditional significance level. This result is in keeping with the literature regarding the importance of the lens that one is using when evaluating an opportunity (Dearborn and Simon, 1958; Aguilar, 1967). It appears that the nature benefits of Mass Customization to the customer is peaking the interest of those with a reported Marketing background. At the same time, individuals within companies with a strong market focus also are more agreeable to the virtues of Mass Customization.

The size variable loading may reveal a certain apprehension to Mass Customization unless an individual believes an organization has the financial strength to move into this new direction. However, the impact on size is minimal in the 5-year

timeframe and does not even appear in the longer 10-year timeframe as indicated by the results depicted in Table 5.12 and Table 5.13. The disappearance of size as an important variable predicting the adoption of Mass Customization can be intepreted as a recognition that financial considerations will give way to strategic imperatives as individuals look further out.

TABLE 5.13

STEPWISE REGRESSION: 10-Year Timeframe

VARIABLE	PARTIAL R^2	MODEL R^2	F	Significance Level
Background	0.2715	0.2715	23.8496	p<.0001
Strategy	0.0656	0.3371	6.2327	p<.0152

In summary, the results of the Stepwise Regression indicated that ***Functional Background*** and ***Company Strategy*** were the most important indicators of how a participant perceived Mass Customization.

5.2 MODEL DEVELOPMENT

Perhaps the most important contribution of this project to the field is the development of an organizational model of Mass Customization. To this point, most of the literature has either been very conceptual, focusing on the *whats* and *whys* of

Mass Customization or a discussion of specific linkages. The research on this topic has not uncovered a complete model for Mass Customization. It was the hope of this research project to put forth a model that has been evaluated and refined by the leading experts in the field. Such a model serves two important purposes. First, it will serve as a benchmark for future research and begin the process of further refinement. In this manner, this model will be in line with the core ideals of the research process. Second, the model can serve as a beginning point for more detailed studies that focus on only one link in the model. By breaking the model into component parts, researchers will begin to understand the nuances of each important relationship.

In Chapter 3 the Enterprise Model of Mass Customization was developed. That model can be seen in Exhibit 1. The next few sections of this paper are dedicated to describing the process by which the model was tested, refined, and ultimately, adapted to an updated version that incorporates the findings from the research. This latest model can be seen in Exhibit 2.

5.2.1 INTERVIEWS WITH EXPERTS ON MASS CUSTOMIZATION

The proposed model was circulated to leading experts in the area of Mass Customization both from within the industry and at large. It was very important that the model be evaluated by the foremost figures within the field in order to have strong validation. Fortunately, the research model received the level of scrutiny hoped for in the planning stage of this project.

The principle theorists at the inception of the Mass Customization paradigm were kind enough to comply with the request to comment on the model. In a number of instances, these researchers passed the model along to other colleagues with specialized expertise in a particular area of the model. Researchers who commented on the model included Dr. Andy Boynton, Mr. Joseph Pine, Dr. Chris Hart, Dr. Michael Shank, Dr. James Taylor, and Dr. Thomas Vollmann. Anyone familiar with the Mass Customization literature knows of the contributions by these individuals. In addition, industry personnel who had extensive experience with the concept of Mass Customization sat down for an extended interview (The right to include their names was not secured as a matter of course so I am hesitant to include their names. However, they all contributed greatly to the model). All in all, the model was evaluated by individuals from four nations on two continents.

The model evaluation process was quite simple and semi-structured. The model was sent to each expert by either mail, fax, or handed to the evaluator. A description of the model was sent along with the model itself to explain what was proposed to be happening at each node. The evaluator was asked to look over the model and comment on its validity. In particular, they were specifically asked to consider:

1) the model's relevance to the field of Mass Customization as they perceived it;

2) the need for additional elements that may have been missing from the model;

3) the need to eliminate elements that were either inaccurate, redundant, or misleading;

4) the need to change the sequencing of the elements or the linkages between elements.

The researcher in this study is enormously grateful for the cooperation and time that was so freely given during these many conversations. These discussions formed the basis for what is the most important contribution of this study.

5.2.2 CONCLUSIONS FROM THE INTERVIEWS

This section describes the conclusions reached from assimilating all the information gleaned from the interviews on the Mass Customization model. In keeping with the structure provided immediately above, the discussion will be outlined in terms of model relevancy, additional elements needed, elements to eliminate, and, finally, the actual sequencing of the elements.

Model Relevancy.

Perhaps the most rewarding aspect of the interview process was the unanimous positive opinion of these experts regarding the relevancy of the overall model. While particular modifications were offered (addressed below), a conclusion can be safely made that the model captures the essence of the Mass Customization process.

The only areas of concern expressed related to terminology and the need to give the information architecture more prominence. With respect to terminology, there was some concern expressed that the term "modules" as it relates to capabilities

may be somewhat confusing due to the field of Modular Manufacturing in the Operations literature. While this concern has merit, it was concluded from reviewing the literature on Mass Customization and discussions with other leading figures, that the word "modules" should be kept at this time to be consistent with the current literature. It was felt that, given the newness of the topic, it might be counterproductive to fine-tune the terminology. However, this concern certainly implores researchers to clearly define the meaning of the term "Modules" when discussing Mass Customization with an audience.

Another interesting distinction that was suggested was to be careful not to interchange the term "customer order" with "customer interaction". There may be many opportunities to have an interaction with a customer where the firm gains important information about that customer but an order is not placed.

The second concern about the model was a little more fundamental. Some of the scholars indicated that the model needed to indicate more clearly the requirement of a coordinated information flow. Although this requirement is recognized throughout the paper, it was felt that a means should be developed to highlight the critical aspect of information transfer.

The primary reason to resist placing the information patterns in more detail in the model is a concern about the readability of the model. A good model should have parsimony as well as detail. It was agreed on that perhaps a good way to indicate the importance of information flow was to develop a companion model that reflected the

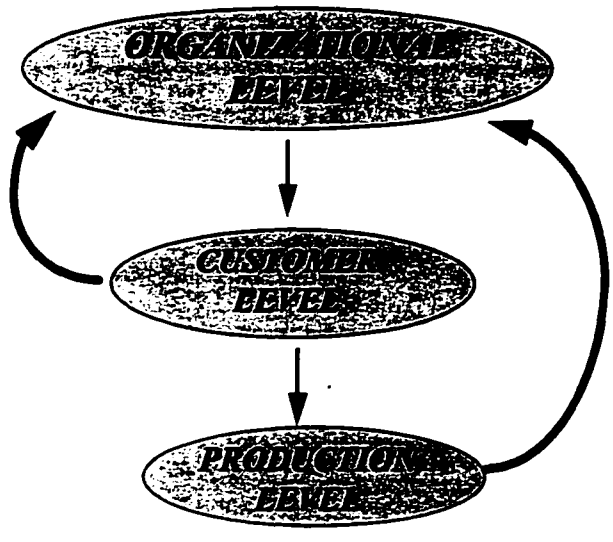
issue. The work of Boynton (1993) provides a good discussion of the types of information within organizations and serves as the reference piece for the companion model displayed in Figure 20.

The companion model attempts to depict a hierarchy of information flow as well as a recognition of the importance of this element to a successful application of Mass Customization. The model portrays information systems playing various roles within the Mass Customization model but yet highly integrated. From the customer or the employee view, the system should appear seamless. From the system designer perspective, the system is an integration of subsystems.

The three architectural levels of the information model for Mass Customization are: Organizational subsystem: Customer subsystem; and Production subsystem. The Organizational subsystem is designed to coordinate both external and internal subsystems. At the Customer subsystem level, systems would transfer information about customers and customer orders. Finally, at the Production subsystem level, the entire processing subsystems would be integrated to enable the efficient and accurate processing of a product or service order. Of course, other subsystems would also be linked to some point but that would be more of an IS issue than a Mass Customization issue.

FIGURE 20

INFORMATION ARCHITECTURE MODEL for MASS CUSTOMIZATION



This companion informational model shares many of the characteristics of the generic Computer Integrated Manufacturing architecture such as the IDEFO model (Jones, Barkmeyer, and Davis, 1994; Johnson, 1994, Mandel, 1994). The key elements of systems integration, informational hierarchy, and simultaneous actions and access can be found throughout all these models. The need for such a companion model is not surprising given the dependency that Mass Customization has on accurate and accessible information.

Additional Elements.

While most of the model appeared to satisfy the experts, one area was mentioned by three different individuals as an opportunity to mass customize that is not shown on the model. This area was distribution capabilities. Using different terms and examples, the three individuals stressed that capabilities to distribute the product in the way the customer prefers can be an important competitive advantage. In addition, there appeared to be quick agreement on how to rectify the model to incorporate this area of customization. Instead of limiting the module choices to product or service characteristics, it was suggested that the choice be extended to include distribution options as well. With this in mind, a new module set ("Distribution Modules") was added to the model. This module feeds into the distribution node in the previous model. In addition, it is now necessary to link the distribution modules to the Sales Assistant Device (SAD) so the customer servicing agent and the customer know the possibilities of customization that this organization can offer.

There was also a remark as to whether the Outsourcing node should be portrayed as modules. This led to a very interesting discussion that ultimately concluded with leaving the model as it is currently structured. The logic behind this decision is that outsourcing is, by definition, something outside the organization and to consider the fact that many suppliers can provide a variety of services may diminish the concept of internal modules.

A final point that was proposed but quickly dismissed by the individual who raised it regarded the addition of a Product Development Module. While it was agreed that this is a critical component of a successful Mass Customizer, it was felt that it was either imbedded in the current modules or was a separate function outside the scope of this model.

Elimination of Elements:

Fortunately, there was little call for the elimination of any of the elements imbedded in the model. The only concern raised along these lines was to combine the Design Tool, Graphic Order Configurator, and the Sales Assistant Device (SAD) in one element. The logic behind this request was that all three are intertwined so tightly that they are, for all intent and purposes, one for both the customer and the customer servicing agent. Although this is true, and especially so in a highly automated process, the suggestion was resisted on the grounds that each is a separate element and should be portrayed as such. Each is also a unique piece of software that typically has to be purchased from software firms competing in very different markets. Perhaps the most persuasive argument for retaining the three elements separately is that the three elements do not necessarily have to be linked electronically. The design tool could be a separate device that aids in the choice process but is not linked to the Graphic Order Configurator. These linkages could be done manually or via another interface.

Regardless of how they are linked, the key point is these are separate elements and should be displayed separately with arrows indicating the need for linkage.

Sequencing of the Elements:

The sequencing issue did not seem to arouse much discussion. However, the addition of the Distribution Modules will require an adjustment in the current sequencing structure. Another idea that has some real merit is to incorporate Vendor Managed Inventory as a post-purchase customization. This is an area for future research as the model becomes refined over time.

One final area of discussion regarding sequencing involved the whole concept of how to best incorporate the financial systems. Currently, the model has the accounting system interacting with the SAD in order to correctly and immediately calculate the proper price for the customer's potential order. While many did not feel comfortable with this issue, there was no one who indicated that the sequencing should be altered from its present configuration.

5.2.3 DEVELOPMENT OF A NEW MODEL OF MASS CUSTOMIZATION

All of the comments from the experts in Mass Customization were analyzed and discussed thoroughly with them. The model is substantially improved by the inclusion of the Distribution Module and the recognition of the importance of information transfer.

Perhaps just as important as improving the contents of the model is the fact that the model withstood a rigorous evaluation by the recognized leading experts in the field of Mass Customization. Their comments support the validity of the model as well as the importance of the study.

The revised model can be viewed in Exhibit 2. This model is placed right behind the original model so as to ease comparison.

5.3 CONCLUSION

This chapter presented the results of the research hypotheses developed in Chapter 3. The methodology followed to accomplish this study was outlined previously in Chapter 4.

The study had two primary sections: hypothesis testing and model verification. The results from the hypothesis testing were very encouraging. Each of the five hypotheses was supported. The model performed well under the evaluation of some of the leading figures in the field. These individuals made a number of important contributions that were added to the model. A revised model incorporating their ideas can be seen in Exhibit 2.

The next chapter is devoted to a discussion of these findings and a call for future research to continue on the efforts began in this study.

CHAPTER SIX:
DISCUSSION OF RESULTS

The previous chapters described the design of a study to address the research questions posed in Chapter 1. These questions were:

1) *Can a model of Mass Customization be developed that is considered valid by leading experts in the field?*

2) *Does the perceived viability of Mass Customization differ across different sectors of the textile complex?*

3) *Will the adoption of Mass Customization be influenced by corporate strategy?*

4) *What effect does individual functional background have on determining who might champion Mass Customization within a firm?*

The first research question was successfully answered by developing a revised model of Mass Customization (see Exhibit 2). This model has been reviewed, reworked, and refined by some of the leading figures in the world on Mass Customization.

The other three research questions were answered by first converting these questions into testable hypotheses and then administering a questionnaire to accumulate the relevant data. The data was analyzed using appropriate statistical tests and the results were formally presented in Chapter 5.

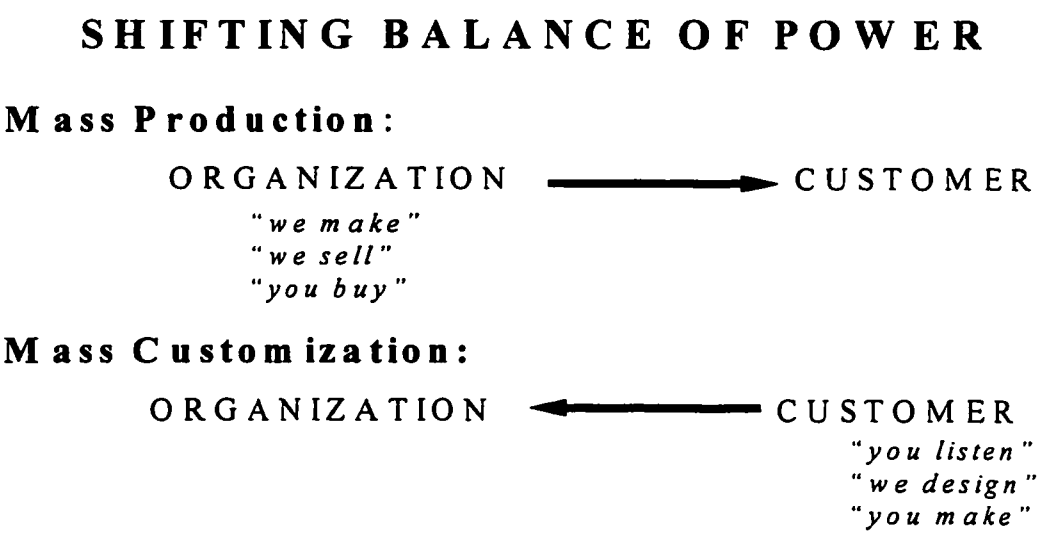
This chapter discusses these results and their implications for industry. In order to maintain a level of continuity, the format for the discussion will follow the logic that was used to develop the hypotheses in Chapter 3. The topic of Mass Customization is viewed from the industry, organizational, and individual perspectives. The Mass Customization model developed in this study is referenced throughout this discussion to provide integration of the material.

Finally, the chapter closes with a section dedicated to looking at future research in the area of Mass Customization. This section examines possible areas for research that are both tightly related to this current study and, also, areas that delve into matters not directly investigated here.

6.1 INDUSTRY IMPLICATIONS

In many respects, industry conditions are actually accelerating the adoption of Mass Customization. Shorter production runs, faster product turnover, competitors from around the globe and a highly demanding customer base are all characteristics of what Pine (1993a) called a "turbulent environment". Tightly held beliefs are often challenged in a turbulent environment (Figure 21 is an example). Pine maintained that a higher turbulent environment is conducive to Mass Customization because firms will be forced to exploit new opportunities in an effort to survive. In many ways, much of the textile industry could be described as experiencing a "turbulent" environment today.

FIGURE 21



However, it is not clear where the virtues of Mass Customization best fit within the industry nor where the resistance to this mega change will flourish. The first hypothesis developed, Hypothesis 1, explored the industry effect. It attempted to determine if participants within the industry perceive applicability of Mass Customization differently across the various sectors within the industry. The results supported the proposed contention that a perception would exist where Mass Customization would be considered more viable as one moved closer to the customer.

While the results agree with the proposed hypothesis, there may be significant unfavorable fallout from this result. Just because someone has a strong *perception,* there is no guarantee that this perception is aligned with reality. Without continually challenging one's perceptions, there is a greater possibility significant change may

escape detection. Mass Customization may provide a vehicle that begins significant changes within textile industry.

Even if the participants are correct and Mass Customization has a higher profile at the finished goods end of the pipeline, there could be important implications for all previous sectors in the value chain. Certain types of fibers may be engineered in such a way as to enable Mass Customization. As Mass Customization grows at the consumer end, the fiber manufacturer that seizes upon this research could reap enormous advantages. Thread manufacturers are anticipating some of these changes by exploring the potential of chameleon thread. This type of thread is colorless but takes on the color of the adjacent fabric. The ability of a garment manufacturer to produce short runs with quick changeover would truly be enhanced by the chameleon thread as thread changeover would be eliminated and thread inventory would be significantly reduced.

Machine manufacturers should also take note of potential changes in machine capabilities that Mass Customization may require as opposed to Mass Production. Single-ply cutters utilizing lasers are definitely aligned better with a Mass Customization future than a faster version of today's technology (DesMarteau, 1995).

Sewing machine manufacturers are today testing a machine that can dye the thread on the machine to reduce the need of changeovers.

Another implication of Mass Customization at the industry level is the impact a Mass Customization movement might have on the industry structure. Consider the

repercussions throughout the industry if the digital printing technology improves to the point where it becomes a quality alternative to dyeing. The historic textile industry pipeline would have to be recast to move colorizing to the final stage. Economists have repeatedly established industry structure as a major determinant of corporate performance (Porter, 1980; Scherer, 1980). Digital printing has the capacity to alter the structure of the textile industry and will open up opportunities for Mass Customization.

Perception is not reality. Individuals and companies throughout the textile pipeline should give serious thought to the implications of Mass Customization to their business. It may be an enormous blunder to dismiss it because of a "That doesn't apply to us, that's an apparel thing" attitude. The investigation undertaken for this research project uncovered major companies throughout the pipeline that are intimately evaluating the potential of Mass Customization for their businesses.

6.2 ORGANIZATIONAL IMPLICATIONS

The organizational implications in this section are related to the hypotheses regarding the influence of a firm's strategy, its production process, and the chosen market in which to compete. The discussion is divided into the three areas with a brief summary section at the end.

6.2.1 STRATEGIC IMPLICATIONS

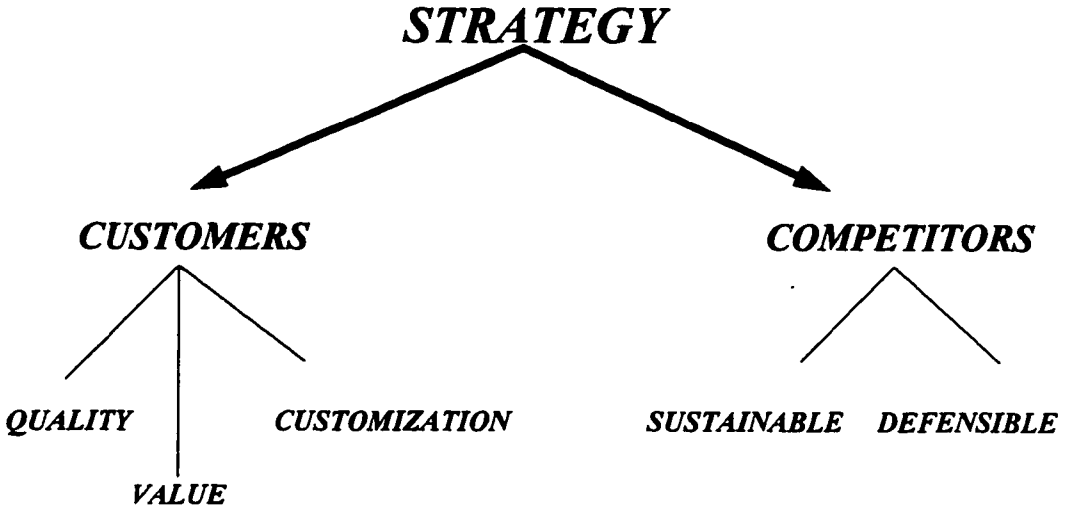
Paraphrasing Pine's (1993a) earlier quotation, Mass Customization presents the opportunity for a firm to garner significant competitive advantages. Hopefully, that will be the driving reason behind why firms adopt Mass Customization. In strategic terms, there are only two reasons to adopt any business platform. Either the adoption leads to a competitive advantage or competition requires the firm to adopt a practice just to maintain position. The reason for adoption could shift over time. For example, the TQM business platform quickly shifted from a competitive advantage in the 1980's to the practically required practice that it is today. In competitive battles, timing is sometimes everything. What eventually becomes an inevitability was often once an opportunity to be seized. Today, firms must evaluate the longer term strategic prospects of Mass Customization for their industry.

Strategy is about attracting and defending -- attracting customers and defending against competitors. Any strategy that fails to consider both is doomed to either short-term success or failure. The ability of Mass Customization to attract customers is self-evident. Theoretically, the customer receives a quality product, at a price comparable to a mass produced version, and yet the item is somewhat customized to their desires. However, the success of attracting customers may be short-lived if competitors recognize how this is being done and are capable of replicating the process. A strategy must be able to construct a sustainable defense in order to justify the expenses incurred to develop the customization process. This two-

prong view of strategy is referred to as the two faces of strategy to represent a firm looking at both the customer and the competitors (Figure 22).

FIGURE 22

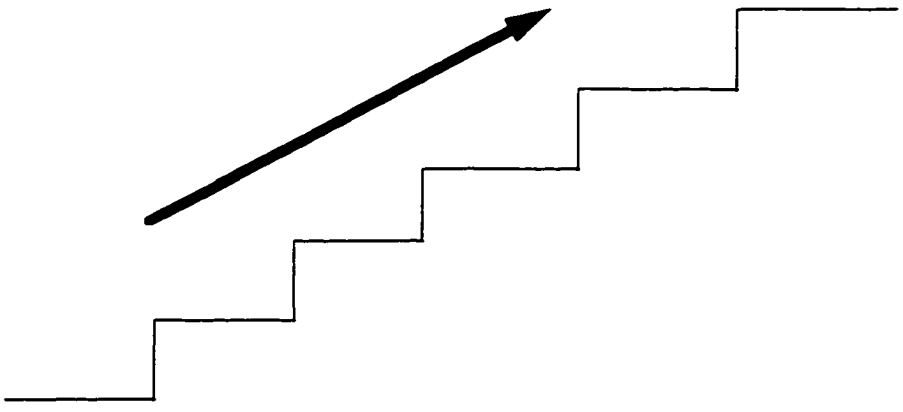
TWO FACES OF STRATEGY



Mass Customization is just the latest of a series of business platforms which firms have adopted in order to gain a competitive advantage or to eliminate an existing advantage of competitors. A depiction of this progression of business platforms and the primary benefit associated with each is seen in Figure 23.

FIGURE 23

CUSTOMER VALUE PROGRESSION



Dimension of Benefit	**Low Price**	**+ Quality**	**+ Delivery Speed**	**+ Product Innovation**	**+ Service / Support**	**+ Customized**
Business Platform	**Mass Production**	**TQM**	**Time-Based Competition**	**Concurrent Engineering**	**Service B/T**	**Mass Customization**

Adapted From: TAYLOR & HART, 1996

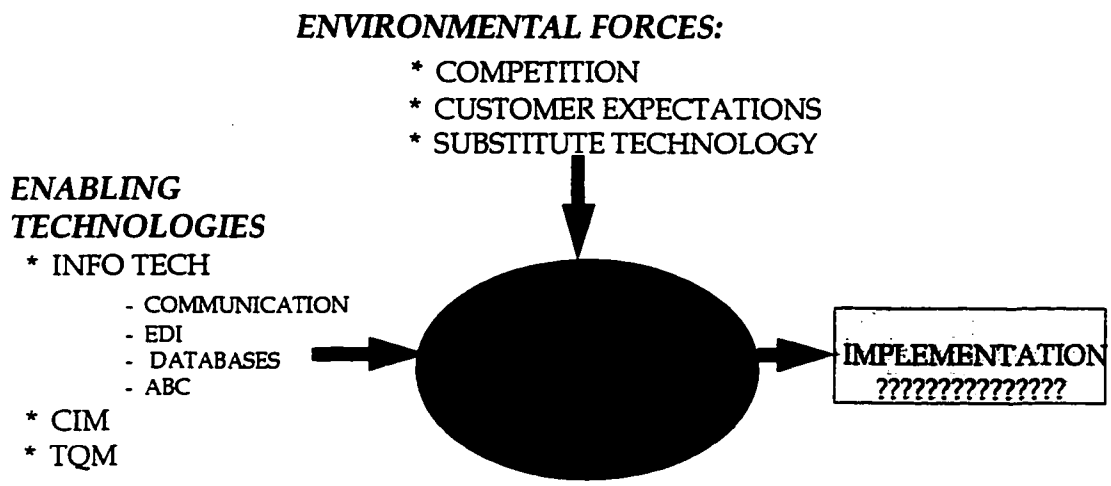
The business platforms have gradually moved through the generic customer needs from value (Mass Production) to quality (TQM, Time-Based Competition, & Concurrent Engineering) to, finally, addressing the customization need (Service Breakthroughs, Mass Customization). Symbolically, the platforms have steadily moved from within factory to meeting with the customer. With this discussion as a backdrop, it is not surprising that the industry participants in the research study felt that Mass Customization was more applicable for market-driven strategies than for production-driven strategies (Hypothesis 4). In fact, the Stepwise Multiple Regression

analysis revealed "strategy" as the independent variable more closely associated with the participant's perception of Mass Customization.

Although the strategic decisions involved with Mass Customization will ultimately determine which firms are successful in this paradigm, the questions one hears the most today by industry personnel are related to implementation. There is great concern about the type of decisions and choices that need to be made before embracing Mass Customization. The forces that are driving Mass Customization are often understood, as are many of the concepts, but how to operationalize them is another matter (Figure 24). The next two sections address these implementation issues at the production and marketing levels.

FIGURE 24

IMPLEMENTATION QUESTIONS

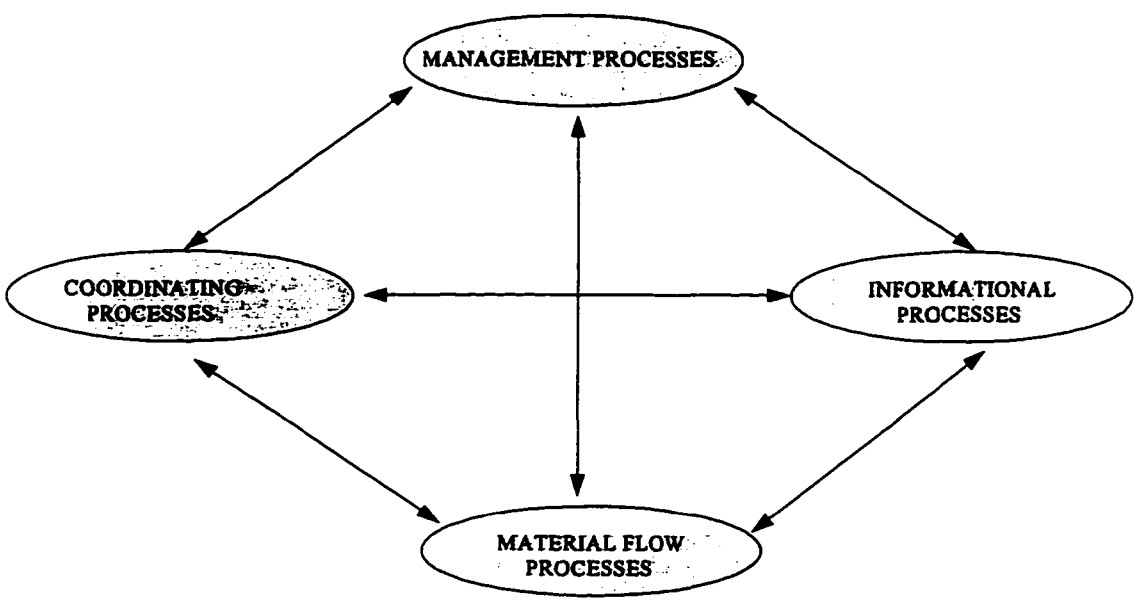


6.2.2 OPERATIONS IMPLICATIONS

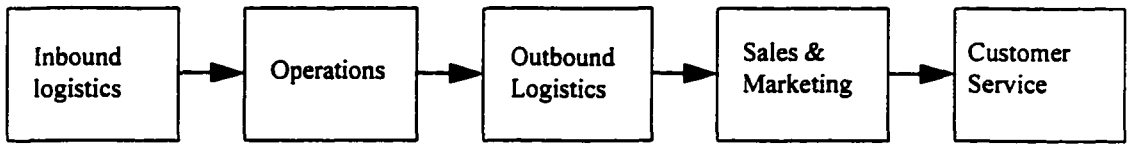
The most pressing implementation question is always how to organize for Mass Customization. On one point there is total agreement -- Mass Customization requires a new level of coordination and integration both within the organization and with external parties such as suppliers and customers. A steady stream of information must be coordinated and tracked on a constant basis. The shop floor must have the capacity to change quickly and adapt as needed. Material needs to flow quickly and accurately to have any chance of keeping up with the demand while keeping down the costs of customizing. This imposing predicament must be met for every single order, every single day (Figure 25 for a schematic of the operational requirements).

FIGURE 25

REQUIREMENTS FOR MASS CUSTOMIZATION



Porter (1985) used the Value Chain as a framework to analyze how a firm should organize itself to add value to its customer. The Value Chain include those elements that have traditionally been crucial to the production of goods and services. The particular elements addressed by Porter include:

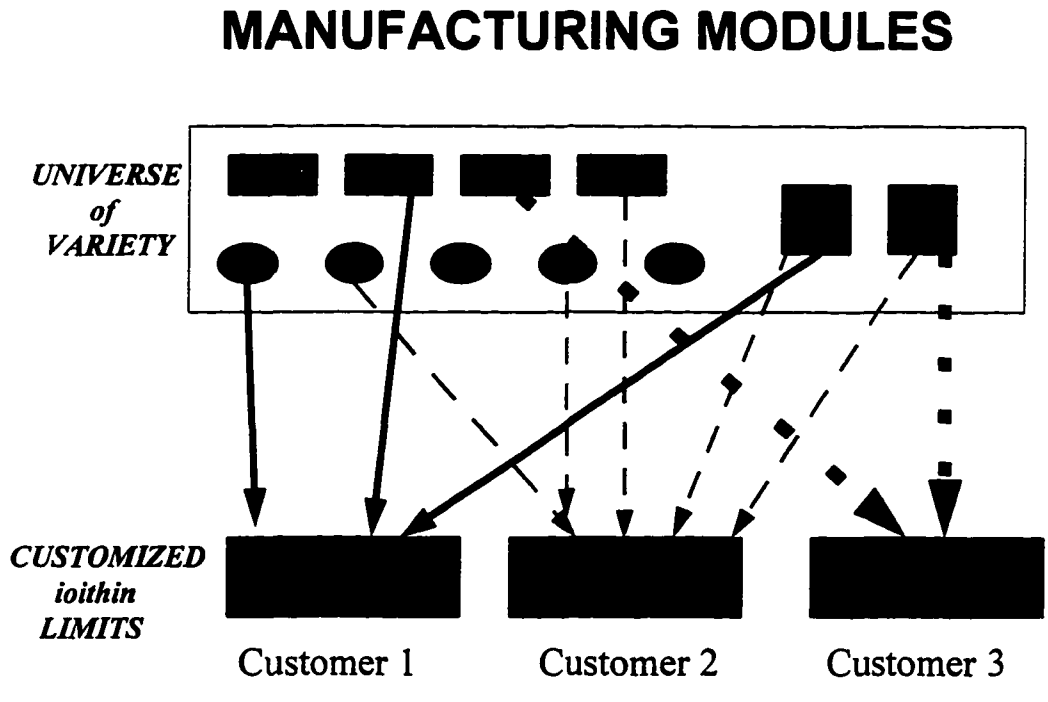


While this chain may represent the key elements for production, there are some important distinction from this framework and the model necessary for Mass Customization. First, the model is quite sequential in nature. There is an explicit linear flow associated with the Value Chain model as typically depicted. When this model is compared to the Mass Customization model in Exhibit 2 it is easy to see that many operations are being done simultaneously. The traditional Mass Production model is a planning-based model that anticipates and projects the demand for the product. That is why the Sales and Marketing link in the Value Chain is so far removed from the initial steps. In Mass Customization, the system begins with a customer order that forces the organization to comply with the desires of the customer. This is a fundamentally different way to view the interaction with the customer and, also, a fundamentally different approach to organizing the work flow.

While the elements of the Value Chain that add value to the customer is no different in either model, there is a significant variation is how that value is being added.

Hypothesis 3 focused on the type of production process the participants perceived as most applicable to Mass Customization. Strong support was found for the assertion that the participants would view an assembly of component parts as a more favorable process than a continuous process. Not only is this logically reasonable, but most of the examples of Mass Customization that are currently in operation use the component assembly process. The primary technique to organize a Mass Customization outfit is to design a modular manufacturing arrangement (see Figure 26 for a generic model operation). The schematic shows three different customers receiving customized products. The amount of potential customization is

FIGURE 26



limited by the "universe of variety" which is the storehouse of the modules that a firm can efficiently offer. Mass Customization does not mean "anything you want" because that would be too costly. What Mass Customization does mean is a much richer variety of choices (limited only by the firm's ability to coordinate modules) at reasonable costs.

Given how critical operations are for a successful Mass Customization offering, it is appropriate that this area receives quite a bit of attention from both academia and industry. However, a number of particular issues have surfaced in the literature. One issue revolves around whether a firm can or should operate a Mass Customization line (a "focused factory") right next to a more traditional assembly line. As mentioned earlier, researchers have split over this issue as have companies in operations (Kotha, 1994). This issue should be an intensely studied area over the next few years.

A second area of contention and agreement centers on the use of CIM in Mass Customization settings. CIM machines have the advantages of being fast on what they are dedicated to do, possess tireless concentration, and are capable of being directly linked into the IT system. However, the machines may not be flexible enough in a setting where a lot of changes are anticipated over a short period of time. It does seem clear, however, that CIM will be an integral part of future Mass Customization efforts because it possesses the potential to effectively convert a continuous process into a

virtual component assembly. The continuous processing sites that were visited relied heavily on CIM.

A final operational concern that will receive considerable attention is how to organize the employees. Mass Customization, by definition, requires a different product or service each time. Therefore, firms must devise a system in which employees can be held accountable yet retain their flexibility. The PC computer companies have adapted forms of Mass Customization but have organized themselves differently.

6.2.3 MARKETING IMPLICATIONS

The marketing implications for Mass Customization are enormous. While IT and manufacturing need to improve their capabilities and streamline or reconfigure their operations, neither of those functions challenge the basic tenets of their disciplines as much as marketing. In Chapter 2 the concept of 1-to-1 Marketing was introduced. This form of marketing requires an individual customer focus that is appropriate for Mass Customization.

There are three primary tenets of this new approach to marketing. First, firms must begin to focus on the most valued customers instead of the most number of customers. The term "most valued" customer means customers that cherish the customization being offered, are frequent purchasers, and are the most profitable. It is crucial to identify these customers and passionately protect them.

A second tenet concerns how firms should view customers. To justify all the time and expense invested in customizing for a particular customer, the firm must begin thinking in terms of lifelong customers. This tenet flies in the face of most sales and marketing compensation systems.

The final tenet involves the defensibilty of the marketing plan. In order to serve the customer better than their competitors, firms need to develop a relationship with the customer. This "learning relationship" is the principal wedge a company can place between its most valued customers and its competitors. Some remaining issues are depicted in Figure 27.

FIGURE 27

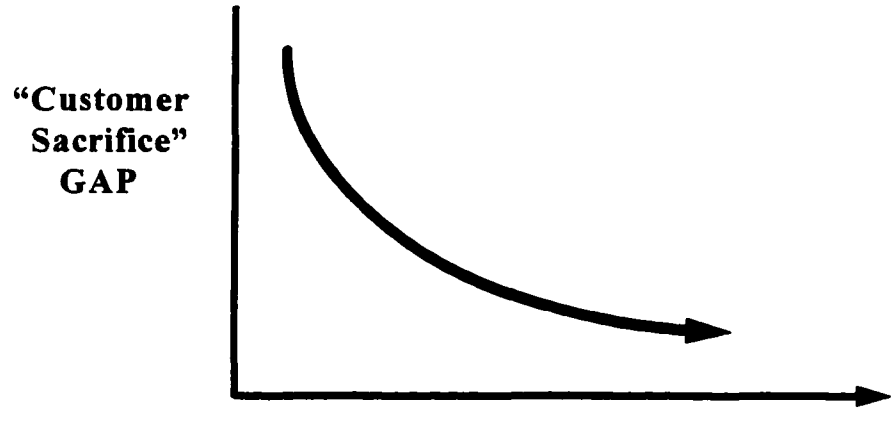
TRADITIONAL MARKETING
vs
1-to-1 MARKETING

Traditional Marketing	*1-to1 Marketing*
◆ Obj.: Market Share	◆ Obj.: Share of Customer
◆ Focus on products/brands	◆ Focus on 1 customer
◆ Targets preferred markets	◆ Targets preferred customers
◆ "Sells to" markets	◆ "Collaborates with" customers
◆ Emphasis on getting new customers	◆ Emphasis on customer retention
◆ Organized by products	◆ Organized by customers
◆ Key is database breadth	◆ Key is database depth
◆ Customer Satisfaction	◆ Customer Sacrifice

While other paradigms have their volume curves and experience curves, the key to the Mass Customization paradigm is the learning curve (Figure 28). Instead of being based on sales or time, this curve is based on the number of opportunities a firm has to interact with its most valued customers where information is shared. The more interactions that take place, the more the firm knows about its customers. And knowing one's customer is the first step to customizing the offering along the dimensions most cherished by these customers.

FIGURE 28

THE NEW LEARNING CURVE



Hypothesis 2 considered the market positioning issue of where to compete in an industry. The participants were asked whether Mass Customization is more appropriate for a niche market or for the primary market. Given the emerging nature of Mass Customization, it is not surprising that the participants supported the hypothesis that the niche market would be deemed superior. While this may seem logical, it should be noted that Mass Customization is the principle method of production in some industries (e.g., personal computers, pagers).

6.3 INDIVIDUAL IMPLICATIONS

Hypothesis 5 dealt with the influence that a person's functional background might have on how he/she perceives Mass Customization. The results supported the contention that individuals with a Market-orientation would view Mass Customization more favorably. That background influences perceptions and, ultimately, behavior which has been a tenet in sociology for a long time (Weick, 1979). The key concern in this study is not so much whether background influences perceptions but what are the implications of this for Mass Customization in particular, and industry, in general.

One implication could be that Mass Customization may be more difficult to adopt given the background composition of management in a particular company. As with anything new, there is always resistance to change that must be overcome. In organizations, sometimes that resistance comes from the structure and policies of the organization which Stinchombe (1965) coined "structural inertia". Just as likely, and

perhaps more dangerous relative to the survival of the firm, the resistance could come from the mindset of the management. If management is too narrow in its focus or repertoire, it may foster a culture that discourages new thinking and new methods. When this type of resistance infects an organization, it is more dangerous because the problem is *the management*, whereas, in the "structural inertia" case, the management can address the problem once they recognize the source.

The results support the notion that a strong and enthusiastic "champion" (Kanter, 1982) may be crucial for the adoption of Mass Customization in firms dominated by individuals with production backgrounds. Perhaps only a true believer can overcome the dual pillars of resistance -- "structural inertia" and cultural mindset.

It is important to step back for a moment and recognize that the above discussion is addressing statistical averages and not implying that all marketing-oriented people possess clairvoyance and operations people are myopic. There are certainly many individuals with operations backgrounds that are as creative and inventive as anyone. In fact, the perfect "champion" for Mass Customization is someone with a production background who can see how the process must operate and also possesses the ability to see the opportunities inherent in this paradigm.

Regardless of anyone's particular background, Mass Customization requires more interaction and coordination among different functional areas within a company than any of the previous paradigms. Managers need to recognize this requirement and

plan accordingly if they intend to reap some of the rewards of Mass Customization for their firm.

6.4 SUMMARY

As a final assessment of the potential of Mass Customization, it may be useful to share a few sets of figures reflecting the benefits of focusing on the customers. In a commercial operation, the key to success is to remain profitable by retaining customers. Why is it so important to retain customers as opposed to acquiring new ones? For one thing, they are cheaper to deal with (Figure 29). The savings associated with retaining old customers rather than always looking to attract new ones flows to the bottom line.

FIGURE 29

CUSTOMER ACQUISITION
VS.
CUSTOMER RETENTION

Cost to Acquire 1 New Customer: *$ 20*

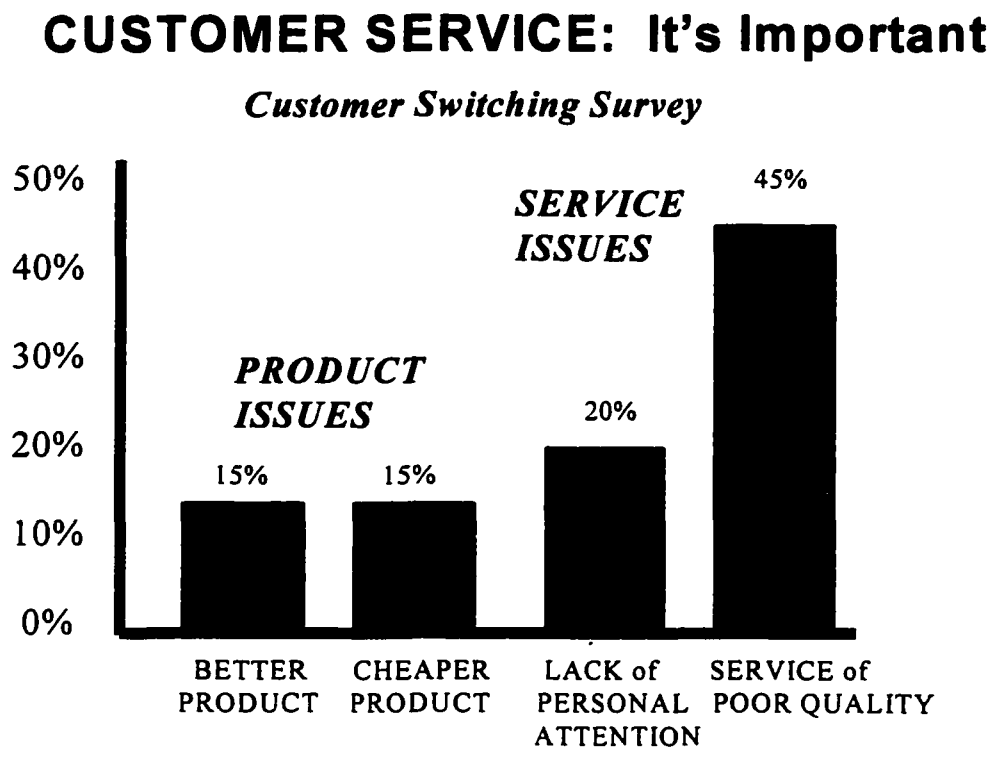
Cost to Retain 1 Current Customer: *$ 4*

SOURCE: Peppers & Rogers, 1993

If retaining customers is so important, then it follows that it should be of utmost interest to know the reasons why customers do switch. As Figure 30 reveals, almost two-thirds of the reasons are directly related to customer service. It seems as if customers can not differentiate company offerings on the basis of price or quality as easily as they can on customer service. This observation supports the contention made earlier in the paper that paradigms build upon previous paradigms. The Mass Production and CPI paradigms selected out those firms that were not able to effectively compete in terms of cost and quality. That leaves customization as the remaining defining factor for retaining customers. That is, at least, while this paradigm is in its infancy. Today, firms can differentiate on either the capacity to deliver a customized offering or understand the individual customer so well that a competitor cannot easily match this level of intimacy.

The concept of Mass Customization is all about giving the customer what he/she wants, when he/she wants it, and where he/she wants it. These options are certainly potential opportunities to provide exceptional customer service and retain valuable customers.

FIGURE 30



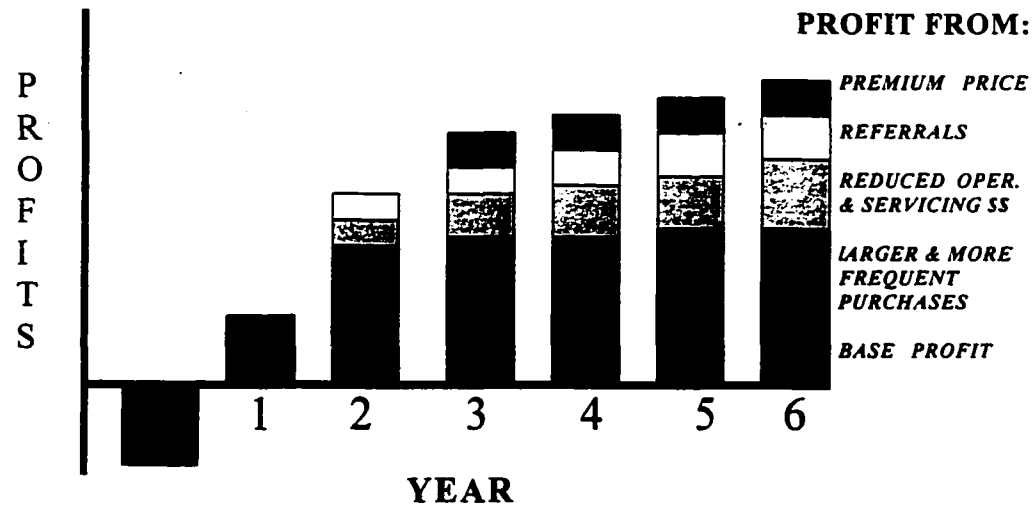
Source: FORUM CORPORATION

If the case for providing customization for customers has not been made on the grounds that it should retain customers better and retaining customers is very cost-effective, perhaps some information regarding the profitability of retaining loyal customers will provide convincing evidence. As Figure 31 depicts, customers become more profitable over time. The initial investment cost to attract the customer is easily amortized over the lifetime of the customer - if that customer is retained. Mass Customization can help firms begin to move out along the curve by constantly learning about the needs of the customer and adapting whenever it is effectively possible. The participants in this study consistently associated Mass Customization

with marketing-orienting firms in small niches. As more and more large, high profile companies begin making inroads into Mass Customization (e.g., John Deere, Motorola, and IBM), this perception may change. As a result, individuals will be challenged to take a broader, more creative view of the possibilities.

FIGURE 31

CUSTOMERS ARE MORE PROFITABLE OVER TIME



SOURCE: Harvard Business Review, Sept-Oct 1990

One final point should be made before embarking on Mass Customization within a particular firm. Companies should not pursue Mass Customization because

they *can* do it but should only pursue it if their analysis says they *should* do it. Taylor and Hart (1996) outlined four factors firms should consider (Figure 32).

FIGURE 32

FACTORS to CONSIDER BEFORE IMPLEMENTING MASS CUSTOMIZATION

- ***COMPETITIVE ENVIRONMENT***
  - ***do you have to do it in order to compete?***
- ***CUSTOMER CUSTOMIZATION SENSITIVITY***
  - ***do the customers value customization enough?***
- ***PROCESS AMENABILITY***
  - ***is the technology available to do it?***
- ***ORGANIZATIONAL READINESS***
  - ***are we capable of doing it?***

TAYLOR and HART, 1996

6.5 FUTURE RESEARCH

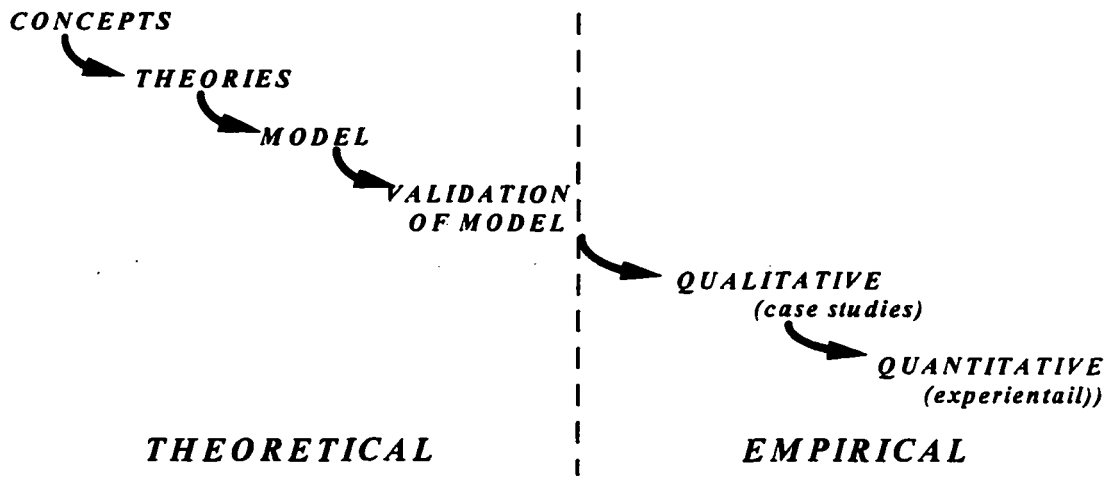
The beauty of research is that no one study can be the definitive study for a topic. There are always more questions to be asked, more twists to be taken, more things to be learned, and more knowledge to be transferred. In more ways than one, this statement is particularly true for this study. Mass Customization is an emerging paradigm with many emerging fields that require further investigation.

Before addressing some specific areas for future exploration, it may be useful to illustrate where the research presented in this paper fits in the research stream of this

emerging paradigm. Figure 33 outlines a theoretical research stream for the development of a new paradigm.

FIGURE 33

NEW PARADIGM DEVELOPMENT RESEARCH STREAM



The Enterprise Model of Mass Customization developed in this research was built upon concepts and theories that are well-established within their own literatures. The contribution of this study resides in the Model Development and Validation of Model stages. These are important components to building a strong theoretical grounding of a new paradigm. It is from such a foundation, and really only from a strong foundation, that empirical research should and can begin.

The second part of the research in this study is more empirical in design. The hypotheses developed and tested did not spring from a Mass Customization model foundation but, rather, from research foundations in other fields that were applied to Mass Customization issues. Because of the recent emergence of Mass Customization, a large-scale empirically based study is virtually impossible at this time. Instead, this study empirically tested propositions about the perceptions of Mass Customization that are currently held. Since perceptions often influence decisions (Aguilar, 1957) and, therefore, reality (Weick, 1979), a study regarding the perceptions of industry participants is appropriate at this time. As the field of Mass Customization matures, the focus of studies should change from perceptions to actions.

What are some logical areas for future investigations? One obvious area would be to replicate this study in another industry to quell concerns about generalizability. Perhaps a large cross-section study across multiple industries would be helpful. It would be interesting to see how Mass Customization is perceived by participants competing in different environments (e.g., services versus manufacturing; consumer versus industrial markets; global versus domestic).

From a strategic perspective, it would be interesting to see how the proposed "first mover advantages" actually play out in the competitive marketplace (or "marketspace" for virtual operations). How firms determine and develop the learning relationships for competitive advantage would provide a glimpse of effective Mass Customization for long-term strategic gain. Another important issue would be

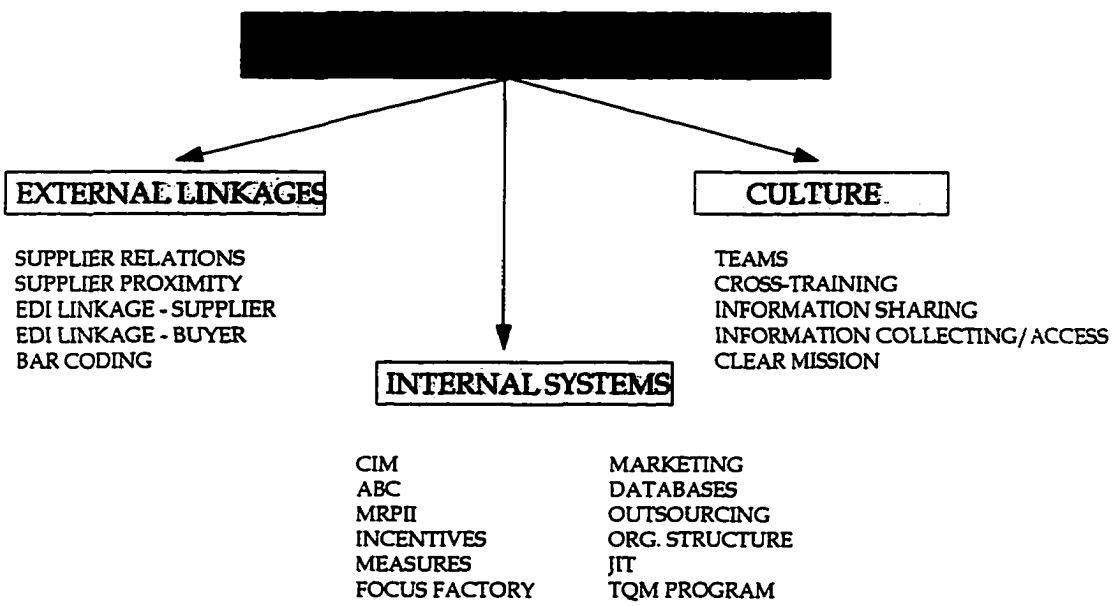
how firms capture, secure, and leverage their customer information. An in-depth study on the different approaches to Mass Customization by companies within the same industry would be enormously significant. To look at the PC industry and view how Dell, Compac, IBM, HP, and Gateway are competing on this basis would be fascinating. In fact, a representative from one of the computer firms provided a wonderful example of the types of issues that will face managers as they attempt to take advantage of Mass Customization. He told of the difficulties experienced by his firm in deciding how to run the operations -- assembly line, teams, or independent projects. The company struggled with a couple of the options before settling on the third. The upshot of the story was the final approach was third on the list because it was the least preferred at the beginning. He then went on to disclose that two other of his closest competitors operate differently. During the course of investigating for this research, many other interesting stories concerning implementation issues surfaced. Mass Customization is still in the "Ferment Era" of the Technology Cycle (Anderson and Tushman, 1986) so experimentation and change should rule the day for a period of time. This is a great opportunity for researchers to provide guidance to managers by uncovering and disseminating concepts that work.

Of course, a very crucial issue facing all companies considering adopting aspects of Mass Customization is the actual implementation of this approach. As indicated above, Mass Customization can be a substantially different way of organizing and working. The "How" questions will be of enormous interests in the

near future. Once people become aware of the potential of Mass Customization and hear the testimonials from other firms, they may be excited but their enthusiasm will be dampened by the nagging thought of, "how do you do it?".

Each element and linkage in the Mass Customization model developed above in Chapter 3 is a potential research site. It will be important and helpful for future researchers to apply concepts and theories from other fields when investigating these elements. Some of the more obvious opportunities raised by the model are depicted in Figure 34. Additional research issues are imbedded within each of these elements and could serve as a topic in their own right.

FIGURE 34
Research Opportunities



Mass Customization can be approached in a multi-disciplinary fashion and should be fruitful for research from fields as diverse as management, marketing, operations, strategy, information technology, accounting, and psychology.

6.6 CONCLUSION

This study began with six major goals to be attained. These goals have been attained only if the reader of this paper can come away from reading with a better understanding of the answers to six basic questions regarding Mass Customization. The questions are:

1) *What is **Mass Customization**?*
2) *What are the **forces driving** Mass Customization?*
3) *Why is Mass Customization a new **Paradigm**?*
4) *What are the Organizational **Issues** of Mass Customization?*
5) *Can a **Model** of Mass Customization be developed?*
6) *What are the **Perceptions** of Mass Customization within industry?*

It has been these six questions which have driven the research described above. Hopefully, anyone who reads this research ill be able to provide informed and reasoned answers to each of the questions.

It has been said that the Japanese character for "change" is a combination of two other characters - the character for "threat" and the character for "opportunity". Mass Customization within the textile industry may be characterized similarly. Some see it as a threat and some see it as an opportunity. The foolish refuse to see it.

"May you live in interesting times."

Ancient Chinese Proverb

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APPENDIX

MASS CUSTOMIZATION
SURVEY QUESTIONNAIRE

CONFIDENTIALITY:
All tabulated information provide below will be kept confidential except for in the form of cumulative data from all participants. Comments will not be attributed to an individual or a company. No one from your company or from another company will see individual questionnaire responses.

DEFINITION OF MASS CUSTOMIZATION: *it is a systematic process of producing a stream of products or services in which each could be different depending on the customer request. It is* ***NOT*** *a traditonal "custom order". The process is designed to customize each order within established capabilities. The ultimate Mass Customization process would be a system capable of economically producing a batch size of one.*

PART 1: DEMOGRAPHIC INFORMATION

Name (optional):_____

Position:_____

Functional Background:_____
(Manufacturing, Engineering, Marketing, Sales, Finance, Research & Development, Other)

Company:_____

Company Size (# of employees): _____

If your company is somewhat diversified in nature, please select a market or product segment for which you are most familiar with when completing this survey.

Business Unit Name:_____

Business Unit's Position in Textile Pipeline:_____
(Fiber Producing, Yarn Mfg, Fabric Formation, Dyeing & Finishing,
Finished Product - Apparel, Finished Product - Other)

Production Process: __ Continuous Process __ Component Assembly Process
__ One of a Kind

PART 2: BUSINESS UNIT STRATEGY

Please read the three strategic approaches below and indicate which one most closely resembles your business unit.

A.____ ***Operational Excellence:*** a company that delivers a combination of quality, price, and ease of purchase. It focuses on execution and cost containment. Processes are streamlined to reduce costs and customer hassle. Operations are often standardized, simplified, tightly coupled, and centrally planned. It exhibits a culture that emphasizes quality, abhors waste, and rewards efficiency.

B.____ ***Product Leadership:*** a company that delivers the latest products or variations to the market. It focuses on innovation, product development, and market exploitation. It attempts to avoid bureaucracy by decentralizing decision-making as much as possible. Its management systems are results-driven that measure and reward new product success.

C.____ ***Customer Intimacy:*** a company that attempts to build bonds with its customer by offering "total solutions" beyond products and price. It attempts to tailor its products and services to the customer. It produces a broad array of options for the customer. It strives for customer loyalty and retention from carefully selected customers.

*In the next 4 sections of the questionnaire please indicate your answers to each question by placing a "**X**" (or some other means of indication) on the scale below each question. Thank you.*

PART 3: MASS CUSTOMIZATION WITHIN THE TEXTILE INDUSTRY

1. How likely is it that Mass Customization will be adopted as a viable means of production in the ***fiber producing*** sector of the industry within **5** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

2. How likely is it that Mass Customization will be adopted as a viable means of production in the ***fiber producing*** sector of the industry over the next **10** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

3. How likely is it that Mass Customization will be adopted as a viable means of production in the ***yarn producing*** sector of the industry within **5** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

4. How likely is it that Mass Customization will be adopted as a viable means of production in the ***yarn producing*** sector of the industry over the next **10** years?

1----------2----------3----------4----------5----------6----------7----------8----------9
Highly Unlikely — Somewhat Likely — Highly Likely

5. How likely is it that Mass Customization will be adopted as a viable means of production in the ***fabric forming*** sector of the industry within **5** years?

1----------2----------3----------4----------5----------6----------7----------8----------9
Highly Unlikely — Somewhat Likely — Highly Likely

6. How likely it is that Mass Customization will be adopted as a viable means of production in the ***fabric forming*** sector of the industry over the next **10** years?

1----------2----------3----------4----------5----------6----------7----------8----------9
Highly Unlikely — Somewhat Likely — Highly Likely

7. How likely is it that Mass Customization will be adopted as a viable means of production in the ***dyeing & finishing*** sector of the industry within **5** years?

1----------2----------3----------4----------5----------6----------7----------8----------9
Highly Unlikely — Somewhat Likely — Highly Likely

8. How likely is it that Mass Customization will be adopted as a viable means of production in the ***dyeing & finishing*** sector over the next **10** years?

1----------2----------3----------4----------5----------6----------7----------8----------9
Highly Unlikely — Somewhat Likely — Highly Likely

9. How likely is it that Mass Customization will be adopted as a viable means of production in the ***finished product - apparel*** sector within **5** years?

1----------2----------3----------4----------5----------6----------7----------8----------9
Highly Unlikely — Somewhat Likely — Highly Likely

10. How likely is it that Mass Customization will be adopted as a viable means of production in the ***finished product - apparel*** sector over the next **10** years?

1----------2----------3----------4----------5----------6----------7----------8----------9
Highly Unlikely — Somewhat Likely — Highly Likely

11. How likely is it that Mass Customization will be adopted as a viable means of production in the ***finished product - other*** sector within **5** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

12. How likely is it that Mass Customization will be adopted as a viable means of production in the ***finished product - other*** sector over the next **10** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

PART 4: MARKET APPEAL OF MASS CUSTOMIZATION

13. How likely is it within the textile industry that Mass Customization will be adopted to exploit ***market niches*** within **5** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

14. How likely is it within the textile industry that Mass Customization will be adopted to exploit ***market niches*** over the next **10** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

15. How likely is it within the textile industry that Mass Customization will be adopted to exploit the ***mass market*** within **5** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

16. How likely is it within the textile industry that Mass Customization will be adopted to exploit the ***mass market*** over the next **10** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

PART 5: PRODUCTION PROCESSES & COMPANY SIZE

17. How applicable is the concept of Mass Customization to products resulting from ***continuous process*** manufacturing?

1	2	3	4	5	6	7	8	9
Not Applicable				Somewhat Applicable				Highly Applicable

18. How applicable is the concept of Mass Customization to products resulting from an ***assembly of discrete component parts*** manufacturing process?

1	2	3	4	5	6	7	8	9
Not Applicable				Somewhat Applicable				Highly Applicable

19. **Large companies** will be the first ones to begin implementing Mass Customization

1	2	3	4	5	6	7	8	9
Strongly Disagree				Indifferent				Strongly Agree

20. **Small companies** will be the first ones to begin implementing Mass Customization

1	2	3	4	5	6	7	8	9
Strongly Disagree				Indifferent				Strongly Agree

PART 6: MASS CUSTOMIZATION WITHIN YOUR FIRM

21. What are the prospects of initiating a Mass Customization program at ***your firm*** in a ***niche segment*** within the next **5** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

22. What are the prospects of implementing a Mass Customization program at ***your firm*** in a ***niche segment*** within the next **10** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

23. What are the prospects of implementing a Mass Customization program at ***your firm*** in a ***mass market*** within the next **5** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

24. What are the prospects of implementing a Mass Customization program at ***your firm*** in a ***mass market*** within the next **10** years?

1	2	3	4	5	6	7	8	9
Highly Unlikely				Somewhat Likely				Highly Likely

PART 7: BARRIERS TO MASS CUSTOMIZATION AT YOUR FIRM

25. Organizational **cultural** issues or the company mindset would be a barrier to MC at my firm

1	2	3	4	5	6	7	8	9
Strongly Disagree				Indifferent				Strongly Agree

26. **Financial investment** in technology would be a barrier to MC at my firm

1	2	3	4	5	6	7	8	9
Strongly Disagree				Indifferent				Strongly Agree

27. Meeting the **operational flexibility** requirements would pose a barrier at my firm

1	2	3	4	5	6	7	8	9
Strongly Disagree				Indifferent				Strongly Agree

28. There is little evidence that our market values customization enough to justify the changes

1	2	3	4	5	6	7	8	9
Strongly Disagree				Indifferent				Strongly Agree

THANK YOU

Kevin J. O'Mara
Professor - Elon College

Dr. Sam Winchester
Klopman Distinguished Professor - NCSU

EXHIBIT 1: MASS CUSTOMIZATION MODEL

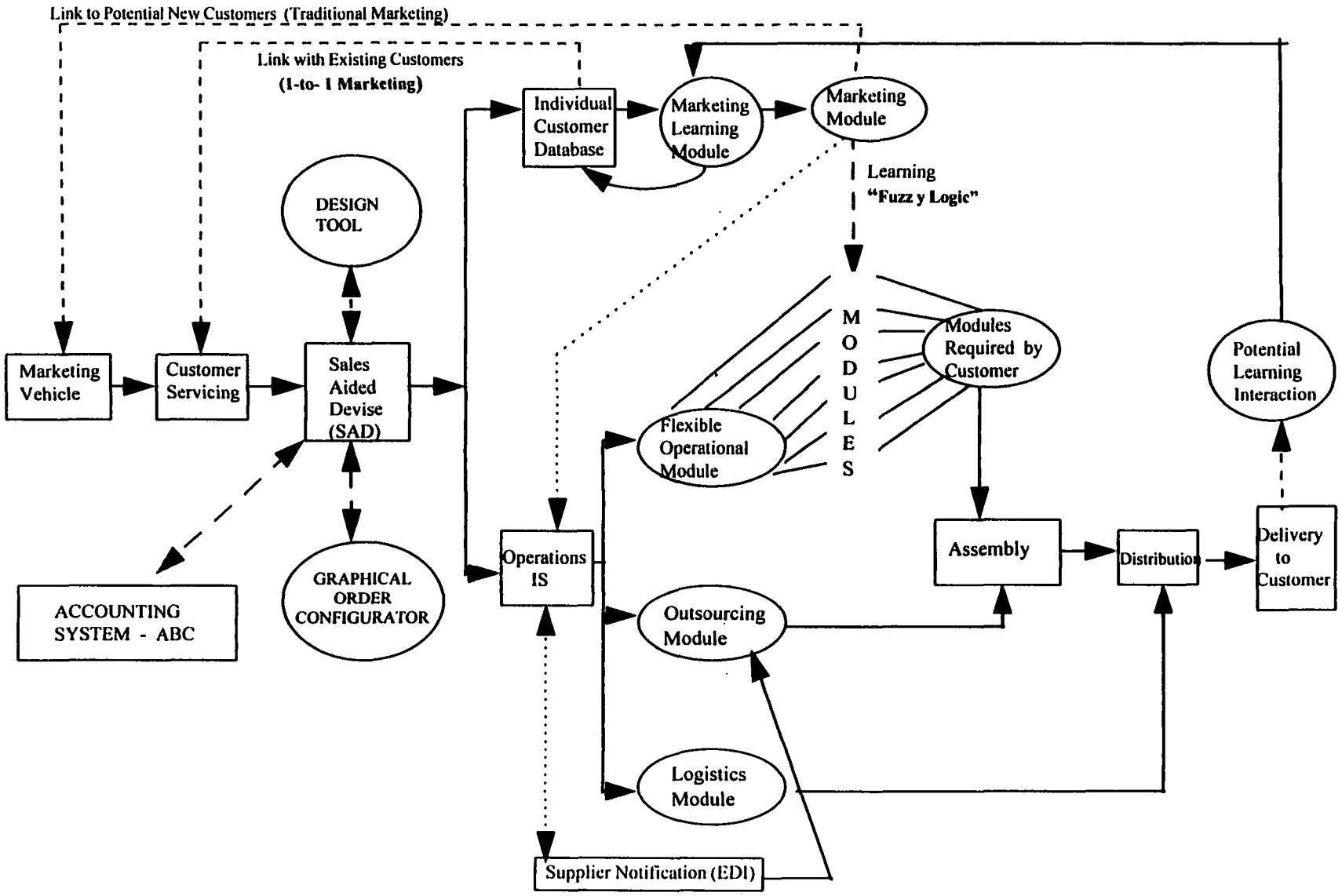

EXHIBIT 2: Revised MASS CUSTOMIZATION MODEL