ABSTRACT

CRAVEN, JENNIFER GILDEA. Building Frameworks for Competitiveness and Innovation: Identification of Strategies and Tactics to Aid the Performance Textile Industry. (Under the direction of Dr. Trevor Little, Dr. Nancy Cassill, and Dr. Marguerite Moore.)

The purpose of this research study was to analyze the performance textile industry in North Carolina in order to identify indicators needed to build a competitiveness framework that companies can use to benchmark themselves. Another purpose of this research was to evaluate new product innovation techniques and identify the strategies used to successfully bring a new product to market. Frameworks for competitiveness and innovation were developed to better understand the critical areas facing performance textile companies.

Performance textiles are defined as *textile materials and products manufactured primarily for their technical and performance properties in addition to their aesthetic or decorative characteristics* (definition adapted from various sources, including 'technical textiles' definition from Horrocks & Anand, 2000 and Nelson, 2008). These materials are a growing sector of the global textile industry. World market expectations for the textile industry are projected at $122 billion in 2010 (IFAI Webinar, 2009). Innovation is key for U.S. companies to stay competitive. There are many types of innovations; however, the ones most examined in this study are the radical, or disruptive, innovations.

The conceptual models used in this study provide frameworks that will aid companies in their competitiveness. New product innovation is a critical step in global competitiveness. Models that were analyzed in this study include Dany Jacob's Lifecycle of Innovation (Jacobs, 2007), Geoffrey Moore's Innovation Types Model (Moore, 2005), and the Textile Added Value Curve (Cassill et al, 2006). Each model involves innovation throughout the product lifecycle. Both models acknowledge the presence of a "chasm" that products must cross in the early stage of innovation. However, the chasm, or "gate," is an area where many promising radical innovations collapse (Jacobs, 2007). This study attempted to analyze how to get across the gate.

The methodology used in this study focused primarily on a quantitative approach to gathering information to answer the research objectives. Convenience sampling of North Carolina performance textile companies was used to create a list of participants for focus groups, both physically at the College of Textiles and also electronically. Participants were asked to complete data collection instruments to build the competitiveness and innovation frameworks according to their own opinions. Results were analyzed and compared to the existing frameworks in order to validate their soundness and make refinements.

Results from the study were analyzed for each of the four research objectives. From the analysis of North Carolina's performance textile industry, results showed that of the 270 companies in the performance textile industry, 33%

are flourishing, 45% are coping, and 21% are potentially vulnerable. In general, performance companies were found to be performing better than non-performance companies. The competitiveness framework showed that the two most frequently used indicators on the chart were “marketing” and “raw material availability.” This framework also identified five new groupings of performance indicators. Three “big strategy areas” and three “big tactic areas” were identified from the five groups, including marketing, material and supply, financial, specification and quality, and new products. Statistical tests were run on the data collected from the innovation framework, and a significant difference was found across the product lifecycle and Moore’s four innovation zones. Moore’s Product Leadership Zone, which deals with the development of new products, was found to be the most important for performance textile companies. The innovation framework results also showed that performance textile companies view innovation in a tactical manner and competitiveness in a strategic manner.

Building Frameworks for Competitiveness and Innovation: Identification of Strategies and Tactics to Aid the Performance Textile Industry

by
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BIOGRAPHY

Jennifer Gildea Craven was born in Indiana, Pennsylvania on October 25, 1985 and was raised in Meadville, Pennsylvania. She is the daughter of Roger Gildea and Sandy Hyland, and has one younger brother, Brian. She graduated from Meadville High School in June 2004. Following graduation, she continued her education at Mercyhurst College in Erie, Pennsylvania, studying Fashion Merchandising. While at Mercyhurst, Jennifer was a Dean's List Scholar and a member of Phi Eta Sigma Honors Society. She was also an active member of the school's newspaper, the *Merciad*, serving as a writer and editor. In May 2008, she graduated Magna Cum Laude with a Bachelor of Science in Family and Consumer Sciences, with a concentration in Fashion Merchandising.

Following her undergraduate degree, Jennifer entered graduate school at North Carolina State University's College of Textiles and was awarded a graduate assistantship funded by the North Carolina Department of Commerce. She plans to complete the requirements to earn her Master's of Science in Textile and Apparel Technology Management in May 2010.

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I also wish to thank my family and friends for the constant love, support and encouragement I needed to complete this research. Most importantly, I would like to thank my parents for providing me with a love of learning and being truly dedicated to my education. And to my husband DJ, who sees me at my best and at my worst, and loves me just the same, thank you.

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CHAPTER 1

INTRODUCTION

Previous research funded by the North Carolina Department of Commerce identified a significant presence of performance textiles in the North Carolina region. The North Carolina performance textile industry is represented in 76 out of 100 counties (Nelson, 2008). The geographic dispersion is statewide with heavy concentration in four specific cluster areas. These areas include the Charlotte area cluster, Triad cluster, Hickory area cluster, and Triangle cluster. These clusters were previously identified as textile clusters in the 2006 study ("State of the Union").

North Carolina has approximately 517 companies competing in the performance textile industry (Nelson, 2008). Twelve major sub-sectors of the performance textile industry were discovered, and the following seven were found to have significant presence in North Carolina: agriculture, apparel, geotextiles, industrial, protective, medical, and construction (Nelson, 2008). Despite the state of the nation's economy, North Carolina is still the number one state for textile manufacturing, including yarn and fabric, the fourth top state for apparel, and it has four of the five largest home suppliers with locations in North Carolina (Godfrey, 2009). Since 2003, there have been 226 new or expanded textile companies in North Carolina (Godfrey, 2009).

Performance textiles are defined as *textile materials and products manufactured primarily for their technical and performance properties in addition to their aesthetic or decorative characteristics* (definition adapted from various sources, including "technical textiles" definition from Horrocks & Anand, 2000). The "performance textile industry" is identified as companies that are involved in the supply to and production and marketing of performance textile products (Nelson, 2008). Techtextil North America, the premier North American trade show and symposium for technical textiles and nonwovens, identifies 12 end-uses of performance or technical textile products.

Description	Markets/ Applications
Agrotech	Agriculture, aquaculture, horticulture and forestry
Buildtech	Building and construction
Clothtech	Technical components of footwear and clothing
Geotech	Geotextiles for landscaping and civil engineering
Hometech	Technical components of furniture, household textiles, and floor-coverings
Indutech	Filtration, conveying, cleaning and other industrial uses
Medtech	Hygiene and medical
Mobiltech	Automobiles, shipping, railways and aerospace
Oekotech	Environmental protection
Packtech	Packaging
Protech	Personal and property protection
Sporttech	Sports and leisure

Figure 1: End-Use Based Divisions of the Technical Textile Industry According to TechTextil
Source: Chang and Kilduff (2002). The US market for technical textiles.

Performance textiles are a growing sector of the global textile industry. World market expectations for the textile industry are projected at $122 billion in 2010 (IFAI Webinar, 2009). While performance textiles are just beginning to become recognized in some areas of the world, in other more developed markets, technical textiles already account for as much as 50 percent of all textile manufacturing activity and output (Horrocks and Anand, 2000).

Performance apparel represents one of the fastest growing sectors of the global textile and clothing industry. Market growth is being fueled largely by the emergence of new fibers, fabrics, products and innovative process technologies (Textile Intelligence, 2009). New innovations are emerging in smart textiles and nanotechnology. The sector's growth prospects are helped by the trend in increasing demand for performance features in mainstream fashion apparel (Textile Intelligence, 2009).

The Industrial Fabrics Association International found that in the United States, specialty fabrics are seeing a slight decline due to the current economy. Textile sales in 2007 accounted for $33.4 billion, yet there was only $30.6 billion in 2008 (IFAI Webinar, 2009). Some of the causes of this decline include the freezing of credit, high cost of raw materials, import pressures and declining number of exports. However, the U.S. has the opportunity and ability to meet the pressures of these

challenges because U.S. companies continually innovate, seek alliances and educate their workforce (IFAI Webinar, 2009). With the current struggles of the global economy, it is critical that companies maintain a high level of innovation in order to remain competitive. Companies agree that the constant need to develop new products, invest in new processes and equipment, and market to a variety of customers, is more demanding and costly than ever (Horrocks and Anand, 2000).

In his book, *Adding Values: The Cultural Side of Innovation*, Dany Jacobs defines innovation as "something new, which is presented in such a way that the value will be determined by the selectors" (Jacobs, 2007, p. 30). There are many types of innovations that occur throughout the lifecycle. The earliest type, and often most difficult to achieve, is a radical, or disruptive, innovation. These innovations concern the development of new products based on new ideas of technology or substantial cost reductions, which completely transform the marketplace (Leifer, 2000). Success, however, is not part of the definition of innovation. The difficulty of getting these radical innovations successfully to market lies with what experts refer to as a "chasm" in the product lifecycle curve. Most product ideas never make it to market, and those that do face a failure rate between 25 and 45 percent (Cooper, 2004). An increase in new product innovation and successfulness through the

chasm will likely result in greater global competitiveness for North Carolina performance textile companies.

Innovation and unique products are not the only measures of competitiveness. Other indicators include manufacturing, customer issues, supplier issues, raw material availability, quality, as well as the original eight criteria for this study: company location, connection in the supply chain, trade capabilities, unique products, Web site, textile association, trade show, and company growth. While all of the indicators of competitiveness are important to an overall success, there are some that are more critical than others. Identifying the most important measures of competitiveness will allow companies to narrow their focus on the vital areas of interest.

Purpose of Research

The purpose of this research was to build a Competitiveness Framework and Innovation Framework, which performance textile companies can use to benchmark their productivity and innovation. Another purpose of this research was to analyze the current standings of North Carolina performance textile companies. Companies were to be classified into categories of Flourishing, Coping, and Potentially

Vulnerable. A goal of the study was to be able to help move all companies "five points to the right" on the competitiveness scale.

Further research into this performance textile industry is important in order to aid companies in their overall global competitiveness. By identifying strengths and weaknesses of companies, the study can build a framework for companies to use to benchmark their productivity and innovation. The goal of the research is to help companies in the performance textile industry make a shift to the right on the global competitiveness scale. That is, give companies the tools they need to help increase their global competitiveness.

In addition to analyzing North Carolina companies' current standings and categorizing them based on performance levels, the research will begin to look at the product lifecycle curve. More specifically, the study will analyze the introduction phase and the issues that accompany new product innovation. By assessing how products move through the "stall phase" of introduction, the research will attempt to answer questions such as: How do products get through the introductory gate and into market? Why do some products succeed while others fail? What can companies do to increase their product's chance of success through the gate?

Research Objectives

- **RO1**: To analyze the North Carolina performance textile industry's global competitiveness by:
  - *Method 1: benchmarking North Carolina textile companies' performance based on the following criteria, established by Cassill, Godfrey, Little, and Frederick in 2006. (Cassill, et al, 2006).*
    - *Company Growth*
    - *Import/Export Capabilities*
    - *Unique Products*
    - *Connection in the Supply Chain*
    - *Trade Show Participation*
    - *Company Location*
    - *Having a Web site*
    - *Textile Association Membership*
  - *Method 2: Categorizing companies into performance levels based on points acquired*
- **RO2**: To create a competitiveness framework, with which companies can benchmark their competitiveness

  - *Method: Perform two-stage research: Focus group followed by data collection instruments to identify importance of 37 performance indicators including the original eight (RO1) and whether these indicators are strategic or tactical.*
- **RO3**: To create an innovation framework based upon Moore (2005), which analyzes different innovation types based on 12 classifications across the product lifecycle
  - *Method: Mailing of data collection instruments to NC textile companies, using key informants to identify strategies and tactics that they perceive to aid in innovation and competitiveness.*
- **RO4**: To refine and validate previous models and frameworks, or create new models, based on findings of focus group participation and data collection instrument responses from industry

Significance of the Study

There was little to no prior research on profiling the North Carolina performance textile industry before Holli Nelson's study in 2007 to 2008. This study adds to the limited empirical literature by incorporating input from performance textile representatives. Additionally, it provides tools that can be implemented into companies' activities and processes for global competitiveness and innovation.

Nelson's research was very successful in identifying a performance "cluster" in the State and the major companies that participate in the performance textile industry in North Carolina. However, further research conducted through this current study will be beneficial to many sources: academia, industry members, and the Department of Commerce. By categorizing companies based on their competitiveness, struggling companies can be targeted and assisted. Additionally, the tools identified through this study can be used to help inform companies of what they need to do to become more competitive.

The research will be important and useful to the performance textile industry. By learning the tools to help aid in new product innovation, companies will have access to the tools to be able to produce more new products and have a higher chance of success in bringing them through the stall phase and into market. This will potentially result in advances in the amount of new products available in the textile industry, as well as profit gains for companies.

The study of new product innovation and "Jacobs' gate" will also be beneficial to companies in order for them to increase productive activities within their business units. By producing more successful new products, companies will continue to become more globally competitive. The intended results of this study are to identify what it takes for new products to successfully make it through the

gate and into market. The value of this discovery will not be limited to the performance textile industry alone. Instead, the results can be used by many industries in order to improve their processes and increase the number of successful innovations.

Limitations of the Study

Limitations of this study include the following:

- *Definitions of the original eight criteria* – Some of the original eight criteria are vague, subjective, and difficult to measure. For instance, criteria such as "growth" and "unique products" may mean one thing to one company and something completely different to another company.
- *Database used to allocate points* – the database established in the 2006 "State of the Union" study (Cassill, et al, 2006) includes associations and organizations that may not relate to the criteria used as weights for this study. Low scores may have resulted for this reason, which may have swayed F/C/PV standings. The performance textile industry is different for the purposes of this study compared to the 2006 study.

- *Sampling method* – A convenience sample of North Carolina companies was used and participating companies were identified by the researcher and College of Textiles faculty. Therefore, the study's results are a generalization of the performance textile industry in North Carolina, and cannot be generalized to the population, rather only to the sample.
- *Sample size of the study* – The response rate for this study was relatively small at 10.5%. One possible reason is that 89% of textile companies in NC are privately held, which may have influenced the response rate of the distribution materials due to the fact that many companies are reluctant to release private company information regarding their practices and processes.
- *Data collection method* – The data collection instruments were sent through the mail, instead of potentially faster and easier methods, such as the Internet or an online format. This could have affected the response rate because of the time it took to complete the physical documents, as well as the hassle of mailing the documents back to the researcher.

- *Innovation Framework Design* – The Innovation Framework's design did not include separate independent variables to be statistically analyzed. For this reason, analyses such as Chi Square tests could not be run on the data.

Conceptual Definitions

Agriculture textiles – Textiles used in agriculture, horticulture, aquaculture and forestry (Horrocks & Anand, 2000).

Application innovation – Type of innovation that develops new markets for existing products (Moore, 2005).

Construction textiles – Textiles used in building and construction (Horrocks & Anand, 2000).

Competitive advantage – Defined as a condition which enables a country or firm to operate in a more efficient or otherwise higher-quality manner than its competitors, and which results in benefits accruing (Porter, 1998).

Disruptive Innovation – Type of innovation that creates new market categories that are making their first appearance in any form (Moore, 2005).

Gates – project review and decision meetings, the vital Go/Kill decision points in the Stage-Gate idea-to-launch framework.

Geotextiles – Textiles used in geotextiles and civil engineering (Horrocks & Anand, 2000).

Industrial textiles – Textiles used in filtration, conveying, cleaning, and other industrial uses (Horrocks & Anand, 2000).

Innovation – Something new, which is presented in such a way that the value will be determined by the selectors (Jacobs, 2007).

Medical textiles – Textiles used in hygiene and medical products (Horrocks & Anand, 2000).

Performance textiles – Textile materials and products manufactured primarily for their technical and performance properties in addition to their aesthetic or decorative characteristics (definition adapted from various sources, including Nelson, 2008).

Product innovation – Type of innovation that focuses on existing markets for existing products, differentiating through features and functions that current offers do not have (Moore, 2005).

Protection textiles – Textiles used in personal and property protection (Horrocks & Anand, 2000).

Strategy – a goal or plan for competitiveness.

Tactic – procedure or method of reaching the goal.

Technical textiles – Textile materials and products manufactured primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics (Textile Terms and Definitions, 2007).

CHAPTER II

LITERATURE REVIEW

The literature review offers an explanation of the conceptual models used for this research, as well as further analysis of new product innovation. Current literature from both industry and academia was used for the study to give a background into the topic.

Conceptual Frameworks

Three conceptual models were used for this research. Two relate specifically to innovation and the other relates to adding value to the textile manufacturing process. The first conceptual model used for this research is Dany Jacobs' *Diversity of Innovation from a Lifetime Perspective* (2007), as shown in Figure 2. This model shows the lifecycle of an innovation through the growth market to the decline market. It also is a key figure to note the chasm that takes place in the early stage of innovation. Jacobs adapted his model from Geoffrey Moore's original model (2005).

Jacob's model is different from other lifecycle models because there is not one possible peak in the diagram. Jacobs altered the model to show numerous peaks, which indicate a product's ability to be revived (Jacobs, 2007). According to Jacobs, product categories "may experience decline at some point, but due to

renewal they can also be revived" (Jacobs, 2007, p. 69). He indicates that some products may come to an end at some point, but others that fulfill basic needs will not. The chasm must be crossed in order for an innovation to be successful in reaching a broader audience in acceptance. Jacobs also notes that too much concentration on technology can cause a crash at the gate. In order to successfully cross, three things must be in place:

1. Relative Advantage – the extent to which the innovation (style) is perceived to be better than the existing product,
2. Compatibility – the extent that the product is consistent with existing values, needs, wants and past experiences,
3. Complexity – the perceived difficulty in understanding and using the innovation (style) (Rogers, 2003).

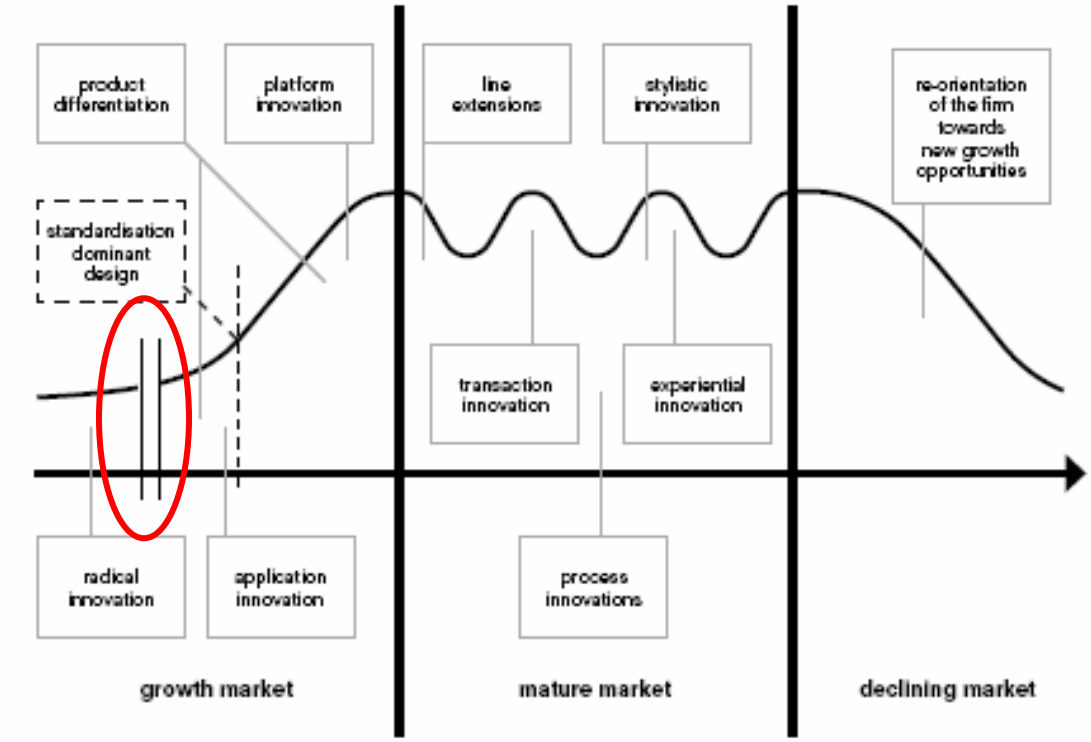


Figure 2: Jacob's Diversity of Innovation from a Lifetime Perspective
Source: Jacobs, D. (2007). Adding Values: The Cultural Side of Innovation. Rotterdam: Art EZ Press/Veenman Publishers.

The second conceptual model used for this research is Geoffrey Moore's Innovation Types Model (2005), which was the base for the development of Jacobs' model. Moore recognizes that there are many different types of innovations along the category life cycle. He identifies four specific innovation zones (See Figure 3), in which lay several types of innovation (See Figure 4).

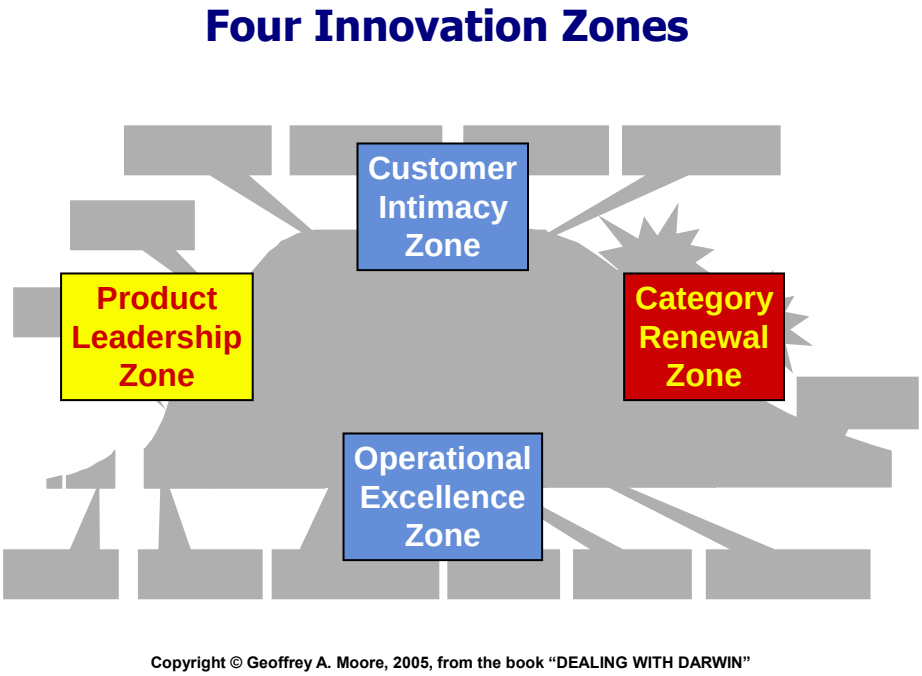


Figure 3: Conceptual Research Model – Four Innovation Zones
Source: Moore, G. (2005). Dealing with Darwin: How Great Companies Innovate at Every Phase of their Evolution. Penguin Group Publishers.

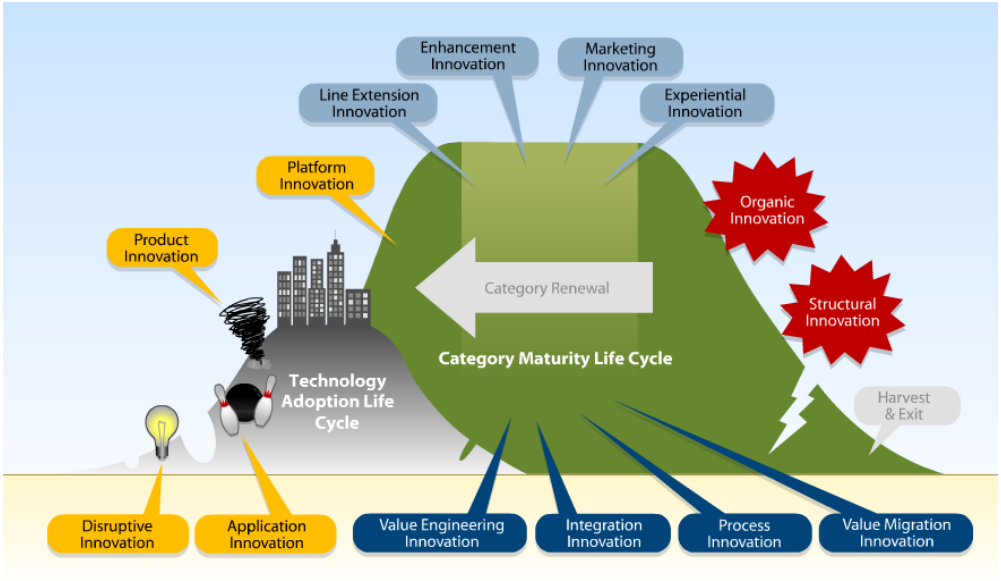


Figure 4: Conceptual Research Model – Innovation Types Curve
Source: Moore, G. (2005) Dealing with Darwin: How Great Companies Innovate at Every Phase of Their Evolution. Penguin Group Publishers.

Moore defines each zone and innovation types as follows:

- Product Leadership Zone
    - Disruptive Innovation: creates new market categories
    - Application Innovation: finds new markets for existing products
    - Product Innovation: existing markets for existing products
    - Platform Innovation: new raw material, new operating system
- Customer Intimacy Zone
    - Line-extension Innovation: structural modifications to give distinctive sub-category

    - Enhancement Innovation: finer elements of detail beyond Line-Extension
    - Marketing Innovation: out-selling instead of out-producing
    - Experiential Innovation: product offers a unique experience
- Operational Excellence Zone
    - Value-engineering Innovation: reduces cost without changing needed product properties
    - Integration Innovation: puts individual components together
    - Process Innovation: reduce waste and non-value adding steps in the process
    - Value migration Innovation: redirecting from commodity to richer margins
- Category Renewal Zone
    - Organic Innovation: internal resources used to reposition product in growth category
    - Acquisition Innovation: category renewal through merger and acquisition

The final conceptual model used for this research is the Textile Added Value Curve. Developed in 2006, the Textile Added Value Curve shows the distribution of added value throughout the manufacturing process. The curve shows that while there is often value added practices and activities in the pre-production and post-production phases, the manufacturing portion is significantly lacking (See Figure 5). The model attempts to lift the curve to make value added activities equal across the entire manufacturing process (Cassill et al, 2006). By assessing the curve of today's textile complex, North Carolina companies can identify opportunities to achieve additional value-added processes through their innovations.

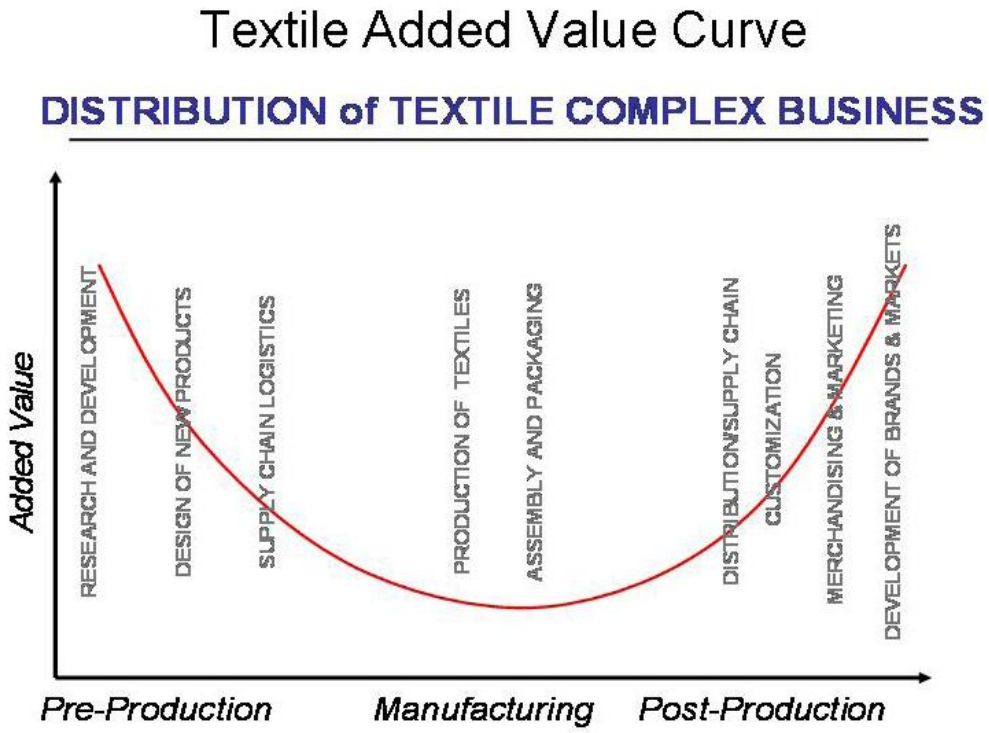


Figure 5: Textile Added Value Curve
Source: Cassill, N.; Godfrey, B., & Little, T. (2006). "The New World of Textiles."

Innovation and Creativity

Innovation happens for many reasons, including to develop new products and methods to enhance productivity and profits. They can destroy existing markets, transform old ones, or create new ones (Hauser, et al, 2006). Innovations come in all shapes and sizes, and therefore, experts in the field of innovation agree that there are many different types of innovation. Of the types of innovation, a

radical innovation is the most disruptive; the most "new." Dany Jacobs defines a radical innovation as "one with the potential to produce one or more of the following:" (Jacobs, 2007, p. 61).

1. An entirely new set of performance features
2. Improvements in known performance features of five times or greater
3. A significant (30 percent or greater) reduction in cost

Radical innovations offer such unprecedented features, or recognizable features with significant improvements. Radical innovations often lead to many other innovations. While these types of innovations are rare, when they do occur they have the potential to alter current markets. While America leads the world in innovation and entrepreneurship, many established firms struggle to continually produce radical innovations, due largely because of their current business models (Leifer, 2000). Richard Leifer identified six general characteristics of the radical innovation lifecycle. According to Leifer, radical innovations are typically:

1. Long term – often a decade or longer
2. Highly uncertain and unpredictable
3. Sporadic – stops and starts, deaths and revivals

4. Nonlinear – requiring a recycling back through activities in response to discontinuities and setbacks and a continuing application of all the key radical innovation project managements competencies
5. Stochastic – key players come and go, priorities change, exogenous events are critical
6. Context dependent – history, experience, corporate culture, personalities, and informal relations all matter, creating a mix of accelerating and retarding factors (Leifer, 2000).

Despite being hard to come by, radical innovations are a major part of the entire innovation process. Innovation as a whole is often the deciding factor between a successful company and one that is less successful. Today, new products account for approximately 32 percent of company sales in the U.S. (Cooper, 2004). Cooper suggests that for every seven new product ideas, about four enter development, one and a half are launched, and only one succeeds. The average time from idea generation through product launch is about 18.4 months (Cooper, 2004). This can be clearly seen in the attrition curve of new products (See Figure 6).

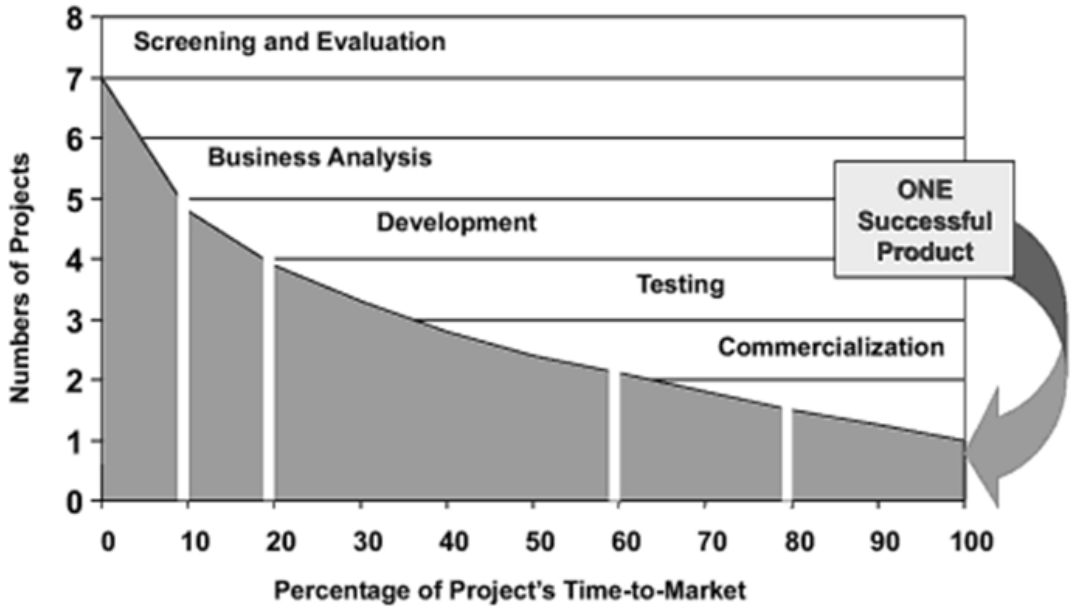


Figure 6: The Attrition Rate of New Product Projects
Source: Cooper, Robert G. (2004). Product Leadership: Pathways to Profitable Innovation. Basic Books.

In conjunction to Moore's "Innovation Types Curve," Cooper gives another outlook on the different types of innovation and new products, which can be seen in Figure 7 along with how much of a percentage each innovation consists of. "New to the world" products are the first of their kind and create an entirely new market. "New product lines" are new to a firm, but not new to the market. They allow a company to enter a new market for the first time. "Additions to existing product lines" are new items to the firm, but fit within existing product lines that the firm makes. "Improvements and revisions to existing products" are replacements of

existing products in a firm's line, or also known as "new and improved" products. "Repositionings" are new applications for existing products, such as retargeting an old product at a new market segment or for a different application. And finally, "cost reductions" are designed to replace existing products in the line, but yield similar benefits and performance at a lower cost. These are the least new of all innovation types (Cooper, 2004).

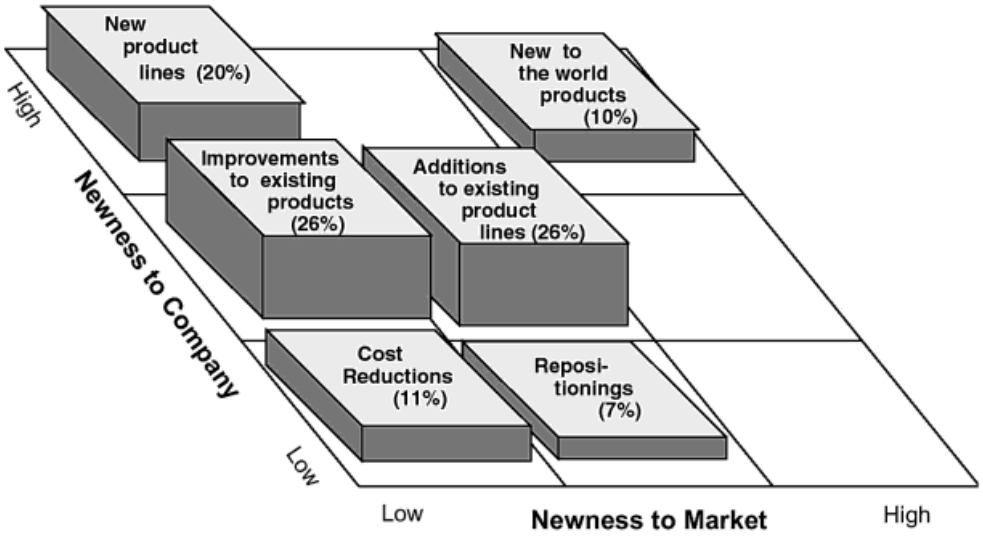


Figure 7: Categories of New Products
Source: Cooper, Robert G. (2004). Product Leadership: Pathways to Profitable Innovation. Basic Books.

According to Cooper, "the total cost of research and development in the 1000 largest companies in the world had equaled one billion dollars per working

day" (Cooper 2004). Experts believe that in order to be successful in competitiveness and product innovation, companies must make sure that R&D creates a genuine product breakthrough, marketing drives home the claim, and that manufacturing can create an uninterrupted supply (Moore 2005). Factors that are associated with a company's ability to innovate include competition and environmental turbulence, clan structure and specialization, and age and education of employees (Hauser, et al, 2006). Several researchers have created a list of "metafactors" related to the successful performance of new technology and product ventures: (Song, et al, 2008).

- Supply chain integration - A firm's cooperation across different levels of the value-added chain (e.g., suppliers, distribution channel agents, or customers)
- Market scope - Variety in customers and customer segments, their geographic range, and the number of products
- Firm age - Number of years a firm has been in existence
- Size of founding team - Size of the management team of the firm
- Financial resources - Level of financial assets of the firm
- Marketing experience - Experience of the firm's management team in marketing

- Industry experience - Experience of the firm's management team in related industries and markets
- Patent protection - Availability of firm's patents protecting product or process technology

One of the most familiar operational models for businesses around the world today is the Stage-Gate approach, developed by Robert Cooper in 2000. Today, nearly 80 percent of North American companies have implemented the Stage-Gate technology into their business units (stage-gate.com). The conceptual model shows how to move a new product from idea to launch in the most efficient and effective manner.

Each stage contains different activities and actions. During the Discovery stage, new product ideas are being formed. During the Scoping stage, a preliminary investigation of the projected product in conducted. During the Build the Business Case stage, a detailed investigation results in the product definition, justification and plan. During the Development stage, the goal is to create a lab-tested product and to formalize market launch plans. During the Testing and Validation stage, trials are conducted in the marketplace to validate the product. Finally, in the Launch stage, the product undergoes full production, marketing and selling (Cooper, 2004).

In between each stage there is a "gate," in which the development team must make critical "go/kill" decisions and prioritization. The checkpoints are designed to control the process and serve as quality control, as well as weed out mediocre or failing product ideas (Cooper, 2004). The gates must be crossed before moving onto the next stage (See Figure 8). Research has shown that the use of a structured process such as Stage-Gate is associated with an increase in successful market entry for new products and a shortened product development timeframe (Hauser, et al, 2006). Cooper suggests that smaller projects might benefit from a shorter, more simplified gate process than more complex projects.

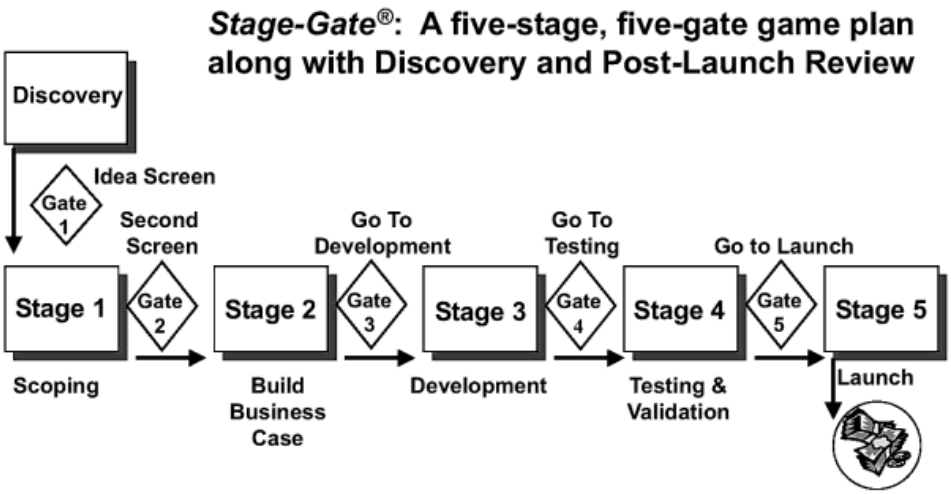


Figure 8: An Overview of the Stage-Gate Idea-to-Launch Framework
Source: Cooper, Robert G. (2004). Product Leadership: Pathways to Profitable Innovation. Basic Books.

Innovation can be classified and determined by many factors, not limited to new products. In fact, some experts believe that location and geography can play a significant role in innovation and creativity. Richard Florida describes why location is a contributing factor of innovation in two of his books, *Who's Your City* and *The Rise of the Creative Class*. According to Florida, "today's key economic factors – talent, innovation, and creativity – are not distributed evenly across the global economy. They concentrate in specific locations" (Florida, 2008, p. 9). Clustering of talented and productive people to several concentrated areas is a source of economic growth. Florida refers to these areas as "mega-regions." Among these high-innovation regions is the "Char-lanta" region, which is home to 22 million people, produces 730 billion in LRP, and encompasses North Carolina's Research Triangle (Florida, 2008); (See Figure 9).

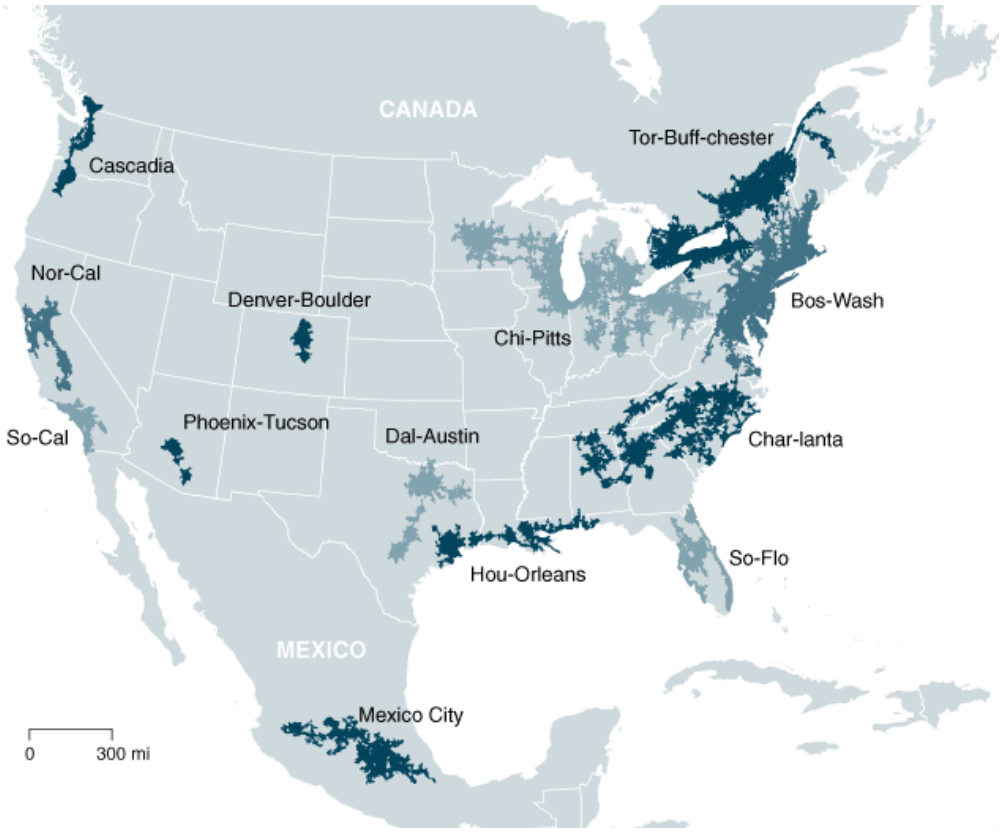


Figure 9: Mega-Regions of North America
Source: Florida, Richard (2008). "Who's Your City? How the Creative Economy Is Making Where to Live the Most Important Decision of Your Life.

Florida also identifies the top innovation areas geographically, as shown in Figure 10. These innovation centers are measured by patents granted worldwide (Florida, 2008). Here, it can be seen that the world's innovation map is made up of numerous peaks and valleys. Top innovators are heavily located in areas such as Japan, Eastern Europe and the United States, specifically the east coast. Florida

notes that worldwide, there are at most two dozen areas that generate significant innovation. These regions are comprised of leading universities, high-powered companies, and venture capitalists that are devoted to innovation and creativity (Florida, 2008).

Figure 10: Innovation in a Spiky World
Source: Florida, Richard (2008). "Who's Your City? How the Creative Economy Is Making Where to Live the Most Important Decision of Your Life.

The "Creative Class," in which Florida refers, "derives its identity from its members' roles as purveyors of creativity" (Florida, 2002, preface). The Creative Class includes approximately 38 million Americans, which is roughly 30 percent of the entire U.S. workforce (Florida, 2002). Regions that rank high on the creativity

index are among the most affluent and growing in the country. Table 1 shows the top 10 ranking creative cities in the U.S. based on The Creativity Index. Raleigh-Durham ranks fourth in the country for innovation, and 14th in the country for being high-tech (See Table 1). Cultural industries can have significant economic impact. In 2009, North Carolina's Department of Cultural Resources and Department of Commerce found that cultural industries contribute about five percent of North Carolina's economy (Cole, 2009). Additionally, these industries "create and sustain more than 293,000 jobs in North Carolina, or 5.54% of total state employment" (Cole, 2009).

Table 1: Top Ten Creative Cities in the U.S.
Source: Florida, Richard (2002). The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life.

Creative Class Rank	*Region*	*Innovation Rank*[a]	*High-Tech Rank*
1	Washington, D.C.	30	5
2	Raleigh-Durham	4	14
3	Boston	6	2
4	Austin	3	11
5	San Francisco	2	1
6	Minneapolis	5	21
7	Hartford, CT	13	26
8	Denver	10	38
9	Seattle	12	3
10	Houston	16	16

Performance or "Technical" Textiles

For the purpose of this research, the term "performance textile" is synonymous with "technical textile" – the terms can be used interchangeably. The textile industry is a significant force in the United States. The sub-industry of "technical" or "industrial" textiles also represents a significant portion of all textile activity in the country (Chang & Kilduff, 2002). A major driver for technical textiles is technical innovation. Globally, technical textiles are considered to be the fastest growing sector of the textile market (Shishoo, 2004). Estimates suggest that in 2000 technical textiles accounted for 30% of end-use fiber consumption in the country, which was worth $17 billion (Chang & Kilduff, 2002). Table 2 provides data specific to the growth of technical textiles, by fiber type, in the United States through 2012. Globally, the industry is expected to expand rapidly, mainly in countries in developing areas like Asia and India (Morris & Wagneur, 2007). Because of lower labor and manufacturing costs, these countries can easily gain market share.

Table 2: US Fiber Consumption of Technical Textiles by Fiber Type, 1995, 2002
Source: Morris, D., and Wagneur, C. (2007). World Markets for Technical Textiles to 2012. Worcestershire, UK: International Newsletters, LTD.

Europe: Production of Technical Textiles, 1995-2012									
('000 tons)									
	1995	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2008***	**2012***
Western Europe	1,079	1,237	1,209	1,265	1,289	1,350	1,287	1,222	1,135
Central, Eastern Europe	90	135	143	129	133	146	147	152	155
Turkey	45	101	104	128	137	145	150	162	175
Total	**1,214**	**1,473**	**1,456**	**1,522**	**1,559**	**1,641**	**1,584**	**1,536**	**1,465**
*Forecasts									

Technical textiles are materials and products intended for end-uses other than non-protective clothing and where their properties outweigh aesthetic or decorative characteristics (Chang & Kilduff, 2002). The technical textile industry is broad and end-use products span a wide variety of industrial applications, including upholstery for automobiles, hoses, medical bandages, construction fabrics, luggage, and tents. "Tensile strength and elongation, weight, elasticity, resistance to flammability and high heat levels, moisture-transport capabilities, durability, and weatherability are some examples of attributes that could be included in a technical textiles performance specification" (Kaufmann, 2003, p. 32). Technical textiles are often characterized by the use of technology often engineered in fiber, yarn, and

fabric form to provide specific technical performance characteristics to meet final requirements (Chang & Kilduff, 2002).

TechTextil (2002) identified twelve end-use divisions for technical textiles:

- Agrotech – agriculture, aquaculture, horticulture and forestry
- Buildtech – building and construction
- Clothtech – technical components of footwear and clothing
- Geotech – geotextiles for landscaping and civil engineering
- Hometech – technical components of furniture, household textiles
- Indutech – filtration, conveying, cleaning
- Medtech – hygiene and medical
- Mobiltech – automobiles, shipping, railways and aerospace
- Oeketech – environmental protection
- Packtech - packaging
- Protech – personal and property protection
- Sporttech – sports and leisure

Performance textiles are also segmented into seven product groups according to TechTextil.

- Technology, machinery and accessories

- Fibers and yarns
- Woven fabrics, scrims, braids and knitted fabrics
- Nonwovens
- Coated textiles
- Composites
- Bondtec

A 2009 study conducted by the International Textile Manufacturers Federation (ITMF) on comparing production costs between eight countries around the globe proves that the U.S. is still a competitor in the global textile industry (See Table 3). The United States is most competitive in the area of rotor spinning for both yarn and knitted fabric. In these categories, the U.S. had the lowest costs in production. Rotor spinning is less labor intensive than ring spinning and tends to be more popular in countries which have higher labor costs (ITMF, 2009). Even in many of the other categories, the United States is not far behind the leaders, coming short by only a few cents. This shows that the U.S. is still very competitive in the textile industry, despite the popularity of offshore production and lower labor costs in overseas countries. It is important for these facts and figures to be recognized

domestically to reinforce the fact that the U.S. has the capability to compete globally, and in fact, is succeeding in doing just that.

Table 3: International Comparison of Production Costs
Source: Textile Outlook International, June 2009.

International Comparison of Production Costs
for 2008, in US$/kg

	Ring Spun Yarn	Rotor Spun Yarn	Woven Fabric (ring spun yarn)	Woven Fabric (rotor spun yarn)	Woven Fabric (textured yarn)	Knitted Fabric (ring spun yarn)	Knitted Fabric (rotor spun yarn)	Knitted Fabric (textured yarn)
USA	**3.22**	**2.08**	**.96**	**.85**	**.86**	**.78**	**.79**	**.67**
Brazil	3.28	2.36	.86	.81	.61	.79	.89	.58
China	3.34	2.57	.85	.85	.56	.79	.95	.53
Egypt	3.46	2.77	.84	.87	.46	.82	1.02	.48
India	2.96	2.19	.83	.81	.55	.71	.82	.47
Italy	4.25	2.60	1.39	1.24	1.10	1.07	1.05	.71
S. Korea	3.23	2.31	.88	.84	.57	.78	.87	.50
Turkey	3.05	2.15	.87	.82	.66	.73	.80	.56

Performance textiles include an array of economic activity, including supporting industries such as raw material producers, machinery and equipment manufacturers, research and development, testing and certification, and education and training organizations (Horrocks & Anand, 2000). A major factor influencing the

industry today is the increase of global competition and pressure from offshore. Competition from Asia and India are forcing the technical textile industry in the U.S. to diversify, innovate, and remain strong in order to compete. "The current perception is that U.S. and European technical textile manufacturers are the leaders in innovation, performance, quality, and technical merit of these engineered products, making them less susceptible to possible litigation" (Kaufman, 2003, p. 32).

While the performance textile industry is relatively difficult to enter due to high entry barriers, costs, and difficulty breaking into markets, some characteristics of technical textiles are becoming more commonplace in the United States (Nelson, 2008). Features such as strength, fire retardancy, and temperature resistance are now becoming requirements in many niche markets. As consumers demand more products and new products, the industry is changing from being driven by technology push to market pull (Rigby Associates, 2002).

Related Literature

Two other studies provided much of the background information for this research. The first study is entitled, "Building the Performance Cluster in North Carolina: Providing Assistance to Enhance Global Market Competitiveness of the

North Carolina Textile Industry," by Holli Nelson in 2008. The second study is entitled, "State of the Union of the Textile Industry in North Carolina: Improving Global Market Competitiveness with Identification and Assistance of Core Competencies," by Nancy Cassill, Blanton Godfrey, Stacey Frederick and Trevor Little in 2006.

Nelson's study identified a significant presence of performance textiles in the North Carolina region. The North Carolina performance industry is represented in 76 out of 100 counties (Nelson, 2008). The geographic dispersion is statewide with heavy concentration in four specific cluster areas. These areas include the Charlotte area cluster, Triad cluster, Hickory area cluster, and Triangle cluster. These clusters were previously identified as textile clusters in the 2006 study ("State of the Union"). North Carolina has approximately 517 companies competing in the performance textile industry (Nelson, 2008). Twelve major sub-sectors of the performance textile industry were discovered (See Figure 11), and the following seven were found to have significant presence in North Carolina: agriculture, apparel, geotextiles, industrial, protective, medical, and construction (Nelson, 2008). Eleven percent of the companies are publicly held, while the remaining 89% are privately held. In 2007, the collective performance textile companies in North Carolina provided an estimated $18,094,043,464 in annual sales (Nelson, 2008). Table 4 summarizes the

key findings of the 12 sub-sectors of the performance textile industry in North Carolina.

Figure 11: North Carolina's Performance Textile Industry
Source: Nelson, H. (2008). "Building the Performance Cluster in North Carolina: Providing Assistance to Enhance Global Market Competitiveness of the North Carolina Textile Industry."

Table 4: Comparison of North Carolina Performance Textile Sub-Sectors
Source: Nelson, H. (2008). "Building the Performance Cluster in North Carolina: Providing Assistance to Enhance Global Market Competitiveness of the North Carolina Textile Industry."

Sub-Sector	Sales $ (estimated)	Sales Rank	Number of Companies	Company Rank
Agriculture	$229,012,542	11	35	10
Construction	$726,213,045	9	32	11
Geotextiles	$227,572,542	12	40	8
Home Furnishings	$1,123,668,992	7	90	4
Environmental	$346,993,650	10	36	9
Packaging	$749,670,067	8	60	7
Sport	$1,390,519,811	6	69	6
Apparel	$2,368,699,845	3	73	5
Protection	$1,607,474,400	4	91	3
Industrial	$7,887,113,398	1	273	1
Medical	$1,513,621,608	5	92	2
Transportation	$3,367,312,345	2	69	6

A Performance Industry Value Chain was developed to depict the broad scope of economic activity that is influenced by performance textiles. In the value chain, the 12 subsectors are surrounded by supporting industries and suppliers (See Figure 12). Supporting industries are critical to the performance industry and its growth opportunities (Nelson, 2008).

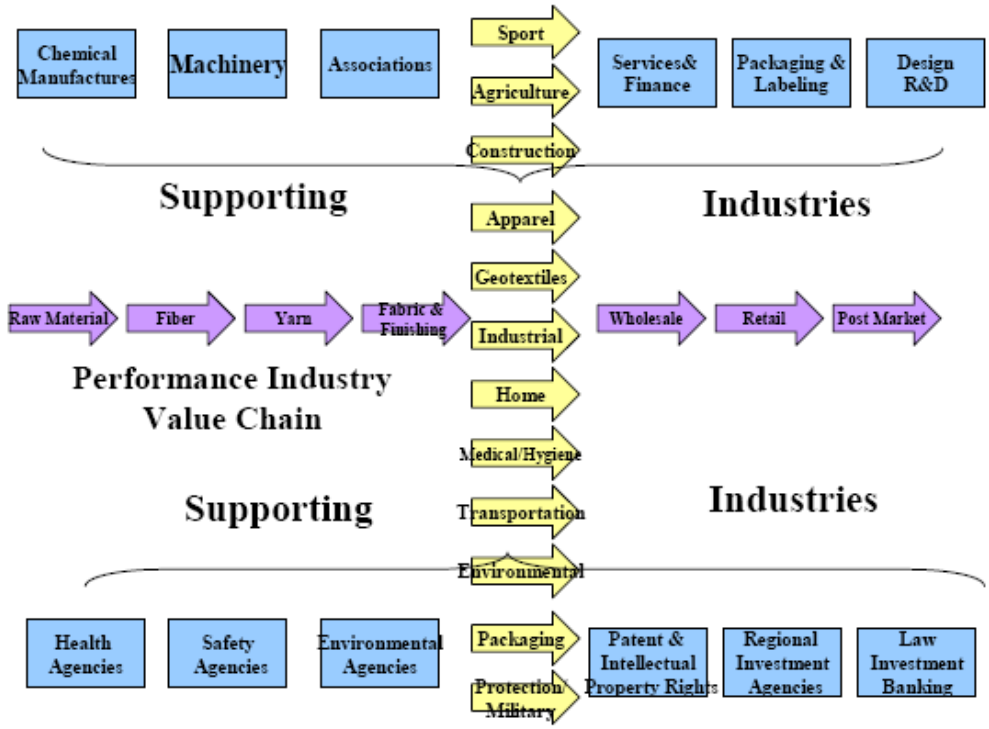


Figure 12: Performance Industry Value Chain
Source: Frederick, S. and Nelson, H. (2008). Extended Textile Value Chain.

Nelson found that innovation is a critical step in global competitiveness. During the focus groups held in 2006 and 2007, companies discussed the importance of innovation and how to successfully implement processes. Key findings include (Nelson, 2008):

- Innovation awareness and processes are necessary for growth.
- Radical innovations are always sought, but process innovations often occur more frequently.

- In terms of success, market pull approach is generally 50% successful, while technology push is 20% successful.
- For radical innovations to be successful, companies must tie together all aspects of the supply chain.
- In terms of the Innovation Lifecycle, 80% of product markets lie in the mature phase, 10% in the decline phase, and 10% in the growth phase. Mature market placement can achieve continued sustainability through partnerships, acquisitions, and strategic alliances (Nelson, 2008).

In the 2006 study, "State of the Union of the Textile Industry in North Carolina: Improving Global Market Competitiveness with Identification and Assistance of Core Competencies," the current state of the textile industry in the United States and specifically in North Carolina was analyzed. Several key trends were identified affecting the global textile complex (Cassill, et al, 2006).

1. China dominates apparel and textiles *
2. High-tech and smart fabrics proliferate *
3. Supply Chain Management (SCM) evolves to serve the global market *
4. Synthetic fiber manufacturers face global glut *

5. U.S. linen sales dominated by big-box retailers and discount department stores*
6. The vast majority of shoes sold in the U.S. are now made in China (China dominating other product categories, as well) *
7. Bricks, clicks, catalogs and living rooms (e-commerce and diverse distribution channels) *
8. Alternative sizing is big (attention to large size consumer) *
9. Discount clothing retailers see promise in designer lines *
10. Haute couture designers experience conflicts over costs and control
11. Luxury returns with a new focus on accessories *
12. Mass designers and retailers speed up for fast fashion *
13. Athletic footwear makers look to aethetes (non-athletes), not athletes; and look overseas for new consumers
14. European strategies force U.S. department stores to rethink their business models (market saturation; need for differentiation) *
15. Specialty retailers look forward, and to the past, for new ideas *
16. Some apparel manufacturers still resist outsourcing*

* Denotes potential impact on textile complex in North Carolina
Source: (Plunkett's Research, Ltd;* www.plunkettresearch.com*; 2006)

The 2006 study identified the criteria with which companies would be classified as either Flourishing, Coping, or Potentially Vulnerable. According to the study, "Flourishing companies are global leaders in the marketplace, with both strategies and tactics to provide innovative products and/or services to serve global markets. These well-financed companies are of varying sizes and ownership (public, private), have a global marketing orientation, and are linked with suppliers and customers. These companies should be targeted by North Carolina for growth and expansion" (Cassill, et al, 2006).

"Coping companies have shifted focus in production, product, and market due to global market challenges. Historically producing commodity-type products, these companies are searching for new product and market opportunities and are pursuing 'linked connections' in order to be successful, with some strategies and tactics. These companies can benefit from global and textile industry market and product knowledge and training" (Cassill, et al, 2006).

"Potentially Vulnerable companies are typically focused only on manufacturing with commodity type products and may have experienced financial difficulties, such as cost of capital and loss of sales or market share. With a narrow market focus for products, these production-oriented companies are utilizing some tactics and have experienced plant closings or layoffs, and are generally not 'linked'

in the supply chain and/or with sources for information (research, development, market information). This segment can benefit from Workforce Development and Community College training" (Cassill, et al, 2006).

CHAPTER III

RESEARCH METHODOLOGY

Purpose of Research

The purpose of this research was to build a Competitiveness Framework and Innovation Framework, which performance textile companies can use to benchmark their productivity and innovation. Another purpose of this research was to analyze the current standings of North Carolina performance textile companies. Companies were classified into categories of Flourishing, Coping, and Potentially Vulnerable. A goal of the study was to be able to help move all companies "five points to the right" on the competitiveness scale.

A four-part approach was used to address the research objectives of this study. Part I consisted of the quantitative analysis of North Carolina's performance textile companies' current standings and classification into three performance categories. Part II addressed global competitiveness and focused on the development of the Competitiveness Framework. Part III consisted of creating the Innovation Framework and analyzing market entry strategies and tactics to aid companies in crossing the "chasm." Finally, Part IV focused on refinement of the frameworks and development of new, revised models based on feedback and input from industry participants. Figure 13 provides an outline for the research process.

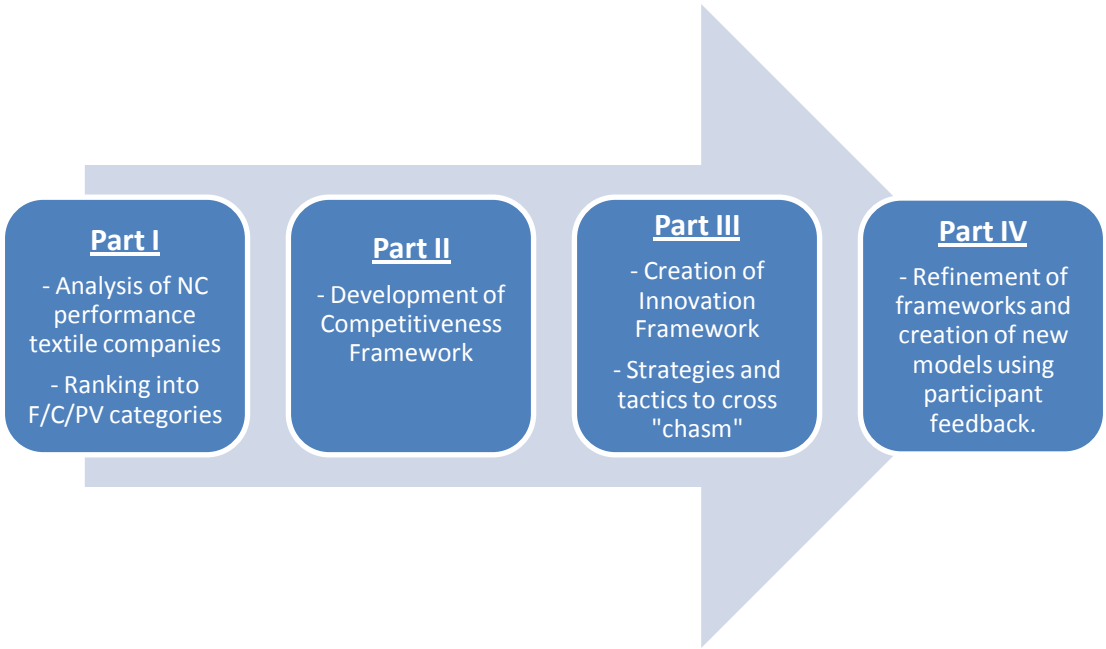


Figure 13: Research Design
Source: Author (Craven, 2009).

Research Objectives

Research objectives for Part I focused on the analysis of North Carolina's performance textile companies and the need to use a point-based system to categorize companies based on their current standing in the industry.

- **RO1**: To analyze the North Carolina performance textile industry's global competitiveness by:

- *Method 1: benchmarking North Carolina textile companies' performance based on the following criteria, established by Cassill, Godfrey, Little, and Frederick in 2006. (Cassill, et al, 2006).*
    - *Company Growth*
    - *Import/Export Capabilities*
    - *Unique Products*
    - *Connection in the Supply Chain*
    - *Trade Show Participation*
    - *Company Location*
    - *Having a Web site*
    - *Textile Association Membership*
- *Method 2: Categorizing companies into performance levels based on points acquired*

Part II of the research focused on the development of the Competitiveness Framework and performance indicators, which industry participants would complete. Results from this tool would be used to reweight the original eight criteria for global competitiveness.

- **RO2**: To create a competitiveness framework, with which companies can benchmark their competitiveness

- *Method: Perform two-stage research: Focus group followed by data collection instruments to identify importance of 37 performance indicators including the original eight (RO1) and whether these indicators are strategic or tactical.*

Part III of the study was conducted in the same manner as Part II, only was creating the Innovation Framework. Responses from participants would help determine which types of innovation are most important, as well as which are perceived as strategies and tactics.

- **RO3**: To create an innovation framework based upon Moore (2005), which analyzes different innovation types based on 12 classifications across the product lifecycle
  - *Method: Mailing of data collection instruments to NC textile companies, using key informants to identify strategies and tactics that they perceive to aid in innovation and competitiveness.*

Part IV of this research is the refinement and validation stage, in which the frameworks will be analyzed for their validity and new models will be developed to better represent the inputs and opinions of participants from the performance textile industry.

- **RO4**: To refine and validate previous models and frameworks, or create new models, based on findings of focus group participation and data collection instrument responses from industry

Statement on the Use of Human Subjects

Prior to the administration of the data collection instruments, an application for the use of human subjects was submitted and approved by the Institutional Review Board (IRB) at North Carolina State University (See Appendix D). In a cover letter distributed with the survey materials, all participants were informed of their rights to participate, not to participate, or to stop participating at any time, as well as the fact that all responses were to be completely confidential (See Appendix B3).

Part I: Analyzing North Carolina's Performance Textile Industry

Sample Selection

The sample selection was determined by a judgment sampling method. The database from the 2006 "State of the Union Study" (Cassill, et al), consisted of 1400 textile companies in North Carolina, including companies with multiple locations and divisions. The database included other company information such as number of employees, markets, geographical location, and financial information. For this

study, the complete list was segmented to create a listing of North Carolina's *performance* textile companies. The final list consisted of 270 performance companies. An important note here is that many of the 270 companies cross into multiple sub-sectors and were counted each time to reach a total number of companies for each sub-sector. Therefore, while there were a total of 517 performance textile company locations identified by Nelson in 2008, this study narrowed the list to single locations of all companies in order for companies to be counted only once. Hence, the final sample size for this study is n=270.

Data Collection

The 2006 study (Cassill, et al) identified eight significant criteria to determine the level of a textile company's global competitiveness (See Table 5). Each criterion was given a weight in points of importance, with 5 being the most important and 1 being the least important. The original criteria and corresponding weights were as follows:

Table 5: Eight Significant Criteria to Rank Performance Textile Companies
Source: Cassill, et al. (2006). "State of the Union of the Textile Industry in North Carolina: Improving Global Market Competitiveness with Identification and Assistance of Core Competencies."

Criterion	Weight
Unique Products	5
Import/Export Capabilities	5
Company Growth	5
Connection in the Supply Chain	4
Participation in Trade Show	3
Company Location	2
Having a Website	1
Belonging to a Textile Association	1

Companies in the performance textile industry were analyzed based on their current practices. Companies that fulfilled the requirements for each criterion were allotted the appropriate points by Cassill, et al in 2006, all of which were tallied to give each company a point total. Whether or not a company received points in a particular category was previously determined in the 2006 study, "State of the Union of the Textile Industry in North Carolina: Improving Global Market Competitiveness with Identification and Assistance of Core Competencies."

Points for each criterion were previously established during the 2006 study. Points identified in the 2006 study were used for this study. Allocation of points was determined in the following way:

- *Unique Products* – 22 potential end-use markets were included in the database. Companies were examined to identify the number of end-use markets in which they were present. Companies that were present in two or more markets were allocated with the point for this criterion.
- *Import/Export Capabilities* – companies earned the point for this criterion if they had shown to import from or export to any foreign country.
- *Company Growth* – growth was determined based on the company's sales in dollars from 2005 to 2007. Companies who saw an increase were allocated the point for this criterion. (Financial information for the 2006 study was provided by the North Carolina Department of Commerce).
- *Connection in the Supply Chain* – Eight areas of the supply chain were included in the database: transportation, service/research, manufacturing, distribution, retailer, sales office, showroom, and design. Companies that were present in two or more areas of the supply chain were allocated the point for this criterion.
- *Participation in Trade Show* – A listing of textile trade shows was included in the database, including MAGIC, IFAI Expo, TechTextil, and ShanghaiTex.

Companies who had participated in any trade show in the past were allocated the point for this criterion.

- *Company Location* – Four major clusters of performance textile companies in North Carolina were identified: the Charlotte area cluster, Triad cluster, Hickory area cluster, and Triangle cluster. Companies that were geographically located in one of these four areas were allocated the point for this criterion.
- *Having a Web site* – Companies who had a Web site in 2006 were allocated the point for this criterion.
- *Belonging to a Textile Association* – A listing of textile associations and organizations were included in the database, including INDA, ATMA, SPESA, and SEAMS. Companies who belonged to any of these textile associations were allocated the point for this criterion.

Data Analysis

Points for each company were summed by the researcher to reach a total number of points for each company. Companies were then sorted into three categories (flourishing, coping, or potentially vulnerable) based on total points. Flourishing companies were companies that had earned eleven or more points.

Coping companies were companies that had earned between six and ten points. Potentially Vulnerable companies were companies that earned between zero and five points. Percentages were calculated in order to compare the current state of the performance textile industry to the entire textile industry in North Carolina. For instance, percentages were calculated to determine what percentage of the performance textile industry was Flourishing compared with what percentage of the entire textile industry was Flourishing. This comparison was important in order to see where the performance textile industry stands in relation to the rest of the textile industry in North Carolina.

Flourishing companies are well-financed, global leaders in the marketplace, with both strategies and tactics to provide innovative products and/or services to serve global markets (Cassill, et al, 2006). Coping companies are producing commodity-type products, and are searching for new product and market opportunities (Cassill, et al, 2006). Potentially Vulnerable companies are focused on manufacturing with commodity type products and may have experienced financial difficulties (Cassill, et al, 2006).

From the list of 270 performance textile companies in North Carolina, seven new lists were formed for each of the seven sub-sectors (apparel, protection, agriculture, industrial, medical, geotextiles, and construction). Only the seven most

significant sub-sectors of the twelve sub-sectors identified by Nelson were analyzed for this study. Nelson found that these seven sub-sectors held the greatest significance for North Carolina's performance textile industry (Nelson, 2008). After allocating points to the entire performance textile industry as a whole, each of the seven sub-sectors was analyzed in the same manner to reach individual totals and percentages for each sub-sector. This allowed for a comparison between sub-sectors, as well as with the entire industry.

Another important area that was analyzed was the difference between how performance textile companies were performing compared to how they *could* be performing (i.e. the points that each company received in this study, versus the points that were available to receive if companies were performing at their best). For each of the eight criteria, the total number of companies that received points in that category was summed. By showing how many companies received points, versus how many *could have* received points, there lies a distinction between the actual performance of the industry or sub-sector versus the potential performance of the industry or sub-sector. For instance, if 250 out of the 270 companies received a point for having a Web site, it could be interpreted that the industry is efficient in this criterion. On the other hand, if only 100 of the 270 companies received a point for participating in a trade show, this might show that the industry is lacking in this

area. By comparing the areas in which the industry is stronger versus the areas that are lacking, the weaker areas can be targeted for improvement.

Parts II and III: Creating the Competitiveness and Innovation Frameworks

Sample Selection

The sample selection was determined by a judgment sampling method. From the list of 270 performance textile companies, 212 companies were chosen at random, to whom the data collection instruments would be mailed. From the 212 companies chosen, 22 companies declined to participate, which brought the final sample size to 190 performance textile companies. A total of 20 responses were collected, which resulted in a 10.5% response rate.

Instrument Development: *Competitiveness Framework*

To begin building the Competitiveness Framework, a list of 37 "performance indicators" was established (see Figure 14 or Appendix C1). This list consisted of different strategies and tactics that contribute to global competitiveness. Among the 37 indicators were the original eight criteria listed above. The list of performance indicators was derived from three sources:

- “State of the Union” study (2006) - The original eight criteria from the 2006 “State of the Union” study were included among the 37 indicators.
- Focus group results from Holli Nelson (2008) – several criteria were selected from Nelson’s fishbone diagrams from her 2008 study. In her focus group results, fishbone diagrams were created to depict the strategies and tactics that performance textiles indicated as important (Nelson, 2008).
- Researcher input – In addition to the criteria from Nelson and the 2006 study, a few additional criteria were added to the list to incorporate items that focus more on innovation.

A “fishbone” diagram was used to visualize the degrees of importance. Formally developed by Kaoru Ishikawa in the 1960s as a basic tool of quality management, the diagram is shaped like the skeleton of a fish, and represents a cause-and-effect-like process. For this study, the fishbone was divided up into five columns, representing the five possible weights of the eight criteria. Column 1, at the “tail” of the fishbone, represents the least important items, while column 5, at the “head” of the fishbone, represents the most important items.

Performance textile company participants were asked to place each of the 37 performance indicators onto the diagram in the section they felt most appropriate. In addition to choosing which column of importance each item was placed, participants had to determine whether each item was a strategy or a tactic. Participants were given definitions of both "strategy" and "tactic" for their reference when filling out the framework. For this study, a strategy was defined as a *goal or plan for competitiveness*. A tactic was defined as a *procedure or method of reaching that goal.* Items placed closest to the "head" of the diagram (column 5) indicated the greatest importance. Participants from the March 12 focus group, as well as the July instrument distribution were presented with the diagram and asked to complete the activity.

Responses from performance textile company participants were analyzed, specifically to see where on the diagram the original eight criteria were placed. For instance, the 2006 study weighted having a Website as only worth one point. However, if numerous participants placed "Website" at the head of the fishbone in the four or five column, the weight of the criteria will likely need to be refined. Additionally, if a performance indicator that was not part of the original eight criteria repeatedly appears as a very important item, it may be necessary to add that as a new criterion.

The goals of the Competitiveness Framework were to a) validate the weights given to the original eight criteria, b) determine whether or not those eight were the most important in determining competitiveness, c) refine the list of most important indicators if new ones were repeatedly used by participants, and d) create a new listing of groups that reflected the areas most important to the performance textile industry.

Instrument Development: *Innovation Framework*

The Innovation Framework was developed using Geoffrey Moore's categories of innovation from his 2005 book, *Dealing with Darwin: How Great Companies Innovate at Every Phase of their Evolution.* Moore identifies four critical innovation zones, as well as several different types of innovations found in each zone (Refer back to Figures 3 and 4 in the Literature Review).

A chart was developed, listing each type of innovation and 17 common attributes that manufacturers and/or marketers face in the textile industry. The list of attributes was created largely from the list of indicators on the Competitiveness Framework. Most of the attributes listed were taken directly from the Competitiveness Framework, and a few others were added to focus on innovation. The list was designed in attempt to identify the value added stages of innovation

and what areas help to cross the chasm. John Bicheno created a flow chart listing similar innovation attributes in his book, *Fishbone Flow* (Bicheno, 2006) (See Appendix E). Items from Bicheno's chart were pulled and used for this study's Innovation Framework.

Attributes were listed down the left-hand side of the chart. Along the top were the twelve innovation types identified by Moore (2005). Definitions for each innovation type were provided to participants. Participants were asked to check the appropriate boxes of the innovation type where each attribute was used. For instance, if meeting target costs is important for disruptive innovations, the corresponding box would be checked.

The goals of the Innovation Framework were to a) identify the dimensions of innovation and understand how each can be measured, b) determine which innovation type holds a greater importance, c) identify the difference between strategic, tactic, and "gray" attributes, and d) compare the results from the Innovation Framework to the results from the Competitiveness Framework to look for similarities and differences.

A second chart was developed as an extension of the Innovation Framework. This chart asked participants to take their top five attributes from the Innovation Framework and describe in more detail how each of the attributes is carried out

within their company. More specifically, the intent was to discover the data that companies collect or would like to collect to support each of the attributes. These responses provided specific examples of real companies' daily activities in North Carolina's performance textile industry.

Pretest

An initial focus group was held on March 12, 2009, in which participants from the performance textile industry met with academic personnel to begin the development of the Competitiveness and Innovation Frameworks, validate their purpose and create a working method of completion (See Appendix A1-A6). The moderator of the focus group was Dr. Trevor Little, professor at the College of Textiles. Representatives from four of the seven performance textile subsectors participated in the focus group, with a total of eight participants. The goal of the focus group was to build and test the models to make sure they were understood and applicable. Findings from this initial focus group were used to refine the models before mailing to a larger representation of the seven performance textile subsectors in July, 2009. The focus group is the most widely used qualitative research method in marketing (Hair, et al, 2008). Advantages of focus groups as a research method include the stimulation of new ideas, face-to-face interaction of

participants, and the ability to bring together hard-to-reach informants (Hair, et al, 2008).

Data Collection

Following the focus group in March, the frameworks were refined and prepped for the larger distribution. In July, the Competitiveness Framework and the Innovation Framework were mailed to 212 performance textile companies in North Carolina (See Appendix B1-B2). The sampling procedure used was a judgment sample. Convenience sampling is "a method of nonprobability sampling where the samples are drawn on the basis of the convenience of the researcher or interviewer" (Hair, et al, 2008, p. 135). Convenience samples are often used in research because they enable a large number of respondents to be interviewed in a relatively short amount of time. This sampling method is commonly used for research such as construct and scale development, as well as questionnaires (Hair, et al, 2008). Twenty responses were collected over a three month period.

Data Analysis: Competitiveness Framework

Responses from performance textile company participants were analyzed to see where the indicators were placed on the chart, as well as the frequency of appearances in the "priority" columns (columns 4 and 5). Numbers were summed to

reach a total for how many times each indicator was listed as a “strategy,” how many times listed as a “tactic,” and also a grand total of appearances for each indicator. Frequency totals for each indicator were then compared to determine which indicators participants viewed as most important for global competitiveness, as well as which indicators were viewed as less important.

Data Analysis: Innovation Framework

The 17 attributes listed on the Innovation Framework were classified as being either “strategic,” “tactic,” or “gray” (gray referring to an attribute that could be both a strategy *and* a tactic). Determination of whether an attribute was a strategy, tactic, or gray was based on Nelson’s fishbone results from her 2008 study, as well as focus group input from the pretest of this study.

Totals for each checked box were added up at the end of each column and row in order to visualize the number of checked boxes for each of the four innovation zones (Refer back to Moore’s model, Figure 3). Percentages were calculated to see in which innovation zone the responses were greatest. This would imply that the innovation zone with the greatest number of check marks is the most important innovation zone for performance textile companies.

Statistical tests were run on the 20 responses using Statistical Package for the Social Sciences (SPSS) in order to find summary statistics that describe the information contained in the responses. Three tests were run on the data set: means test, analysis of variance test, and multiple comparisons. Each of these tests was run for the three categories of attributes (strategic, tactic and gray). The alpha level was set at .05. A chi square test could not be run on the data because there were not two independent variables to analyze. Instead, the variables were dependent upon each other, and therefore could not be analyzed using the chi square method.

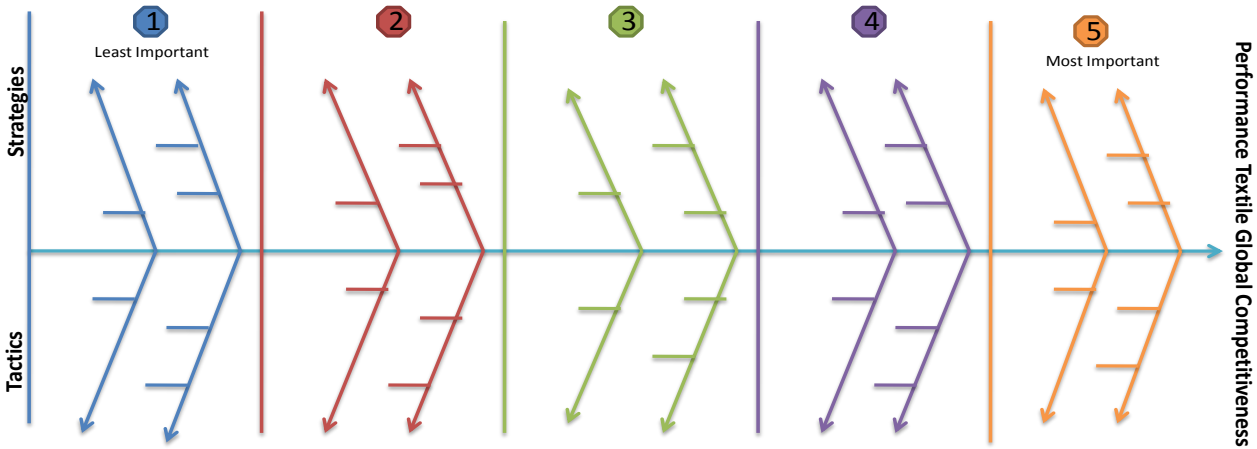
The mean tests looked for the average value in the distribution. It is the most commonly used measure of central tendency (Hair, et al, 2008). The one-way analysis of variance test (ANOVA) was used to determine the statistical difference between the means and to measure the variance within the set of data. Finally, the multiple comparisons test was used to compare means from all categories, as well as report the significance level. For this test, the Games-Howell mean-difference test was used.

The analysis from the Innovation Framework looks at whether or not each of Moore's four innovation zones was viewed equally by participants. If one zone was used more heavily, it will be assumed that that zone is more critical and important to

performance textile companies. The analysis also identified whether participants viewed “strategies” differently than “tactics,” as well as whether one is more important than the other.

To Build the Performance Textile Competitiveness Framework

From the set of Performance Indicators below, write the corresponding letter (A –MM) on the chart to identify its importance and whether it is a strategy or a tactic related to competitiveness.



Strategy: a *plan* or *method* for obtaining global competitiveness.
Tactic: a *maneuver*, *procedure*, or *expedient* for promoting global competitiveness.

Performance Indicators

A. Marketing
B. Own Technology
C. Data
D. Manufacturing
E. Design
F. New Products
G. Product Costs
H. Interest Rates

I. Financing
J. Compliance
K. Economic Order Quantities
L. Quality
M. Supplier Capabilities
N. Supplier Certification
O. Supplier Proximity
P. Supplier Issues (other)

Q. Customer Specifications
R. Customer Lead Times
S. Customer Issues (other)
T. Chargebacks
U. Testing
V. Specifications
W. Raw Material Availability
X. Technology Availability

Y. Company Location
Z. Connection in Supply Chain
AA. Import/Export Capabilities
BB. Unique Products
CC. Promotion
DD. Standards
EE. Global Perspectives of business

FF. Web site
GG. Textile Association
HH. Trade Show
II. Company Growth
JJ. Sustainability
KK. Training and HR
LL. Other _____
MM. Other _____

Figure 14: Performance Textile Competitiveness Framework
Source: Craven, J. & Little, T. (2008)

	Types of Innovation														
	Product Leadership Zone				Customer Intimacy Zone				Operational Excellence Zone				Acquisition Zone	Other	
	Disruptive Innovation	Application Innovation	Product Innovation	Platform Innovation	Line-Extention Innovation	Enhancement Innovation	Marketing Innovation	Experiential Innovation	Value-Engineering Innovation	Integration Innovation	Process Innovation	Value-Migration Innovation			
Attributes															**TOTALS:**
Intellectual Property															
Cost - Meeting target cost															
Standards															
Certification															
Traceability - Component tracking															
End Use Demands															
Technology Availability															
Financial Investment															
Design of Materials															
Design for Aesthetics															
Design to Specification															
Lead Times - Response Time															
Raw Material Availability															
Sustainability															
Compliance															
Time to Market															
Need to Enter New Market															
Other															
Other															
Other															

Figure 15: Innovation Framework
Source: Craven, J. & Little, T. (2008)

CHAPTER IV

RESULTS

This section details the analysis of the four research objectives presented at the beginning of this study. The analysis is broken into the same four-part process as indicated in the Methodology section: a) analysis of the North Carolina performance textile industry, b) Competitiveness Framework, c) Innovation Framework, and d) refinement and validation of the frameworks.

RO1: To analyze the North Carolina performance textile industry's global competitiveness by benchmarking North Carolina textile companies' performance based on the criteria established by Cassill, Godfrey, Little, and Frederick in 2006.

Key Findings:

- 226 new or expanded textile companies in North Carolina since 2003 (Godfrey, 2009).
- NC performance textile industry is 33% Flourishing, 45% Coping, and 21% Potentially Vulnerable.
- Performance textile industry is 21% Potentially Vulnerable, while the entire NC textile industry is 39% Potentially Vulnerable.

- Weakest areas include unique products, participation in a trade show, and connection in the supply chain.

Based on the criteria and weights listed in the Methodology section, 270 performance textile companies were analyzed. Each company had the opportunity to receive 26 points. As defined by the previous College of Textiles study (2006), point allocation is as follows:

- Flourishing: 11+ points
- Coping: 6-10 points
- Potentially Vulnerable: 0-5 points

Totals for Flourishing, Coping, and Potentially Vulnerable were also calculated for each of the seven sub-sectors of the performance textile industry. Percentages for each can be seen in Table 6. Results showed that the majority of performance textile companies in North Carolina are either in the Flourishing or Coping categories. An important observation is that the entire North Carolina textile industry was found to be 39% Potentially Vulnerable, but the Performance Textile industry is only 20% Potentially Vulnerable. This shows that, in general, performance textile companies are performing better than non-performance companies. This is a critical observation, as it shows the importance that the

performance industry holds for the textile industry in North Carolina. Data used to identify the "entire NC textile industry" was from the 2006 research.

Table 6: F/C/PV Percentage Totals for Performance Textile Industry Sub-Sectors

	Sample Size n=	Potentially Vulnerable	Coping	Flourishing
Entire NC Textile Industry	1400	39.0%	36.6%	24.3%
Performance Industry	**270**	**20.74**	**45.19**	**32.96**
Protection	79	25.32	32.91	41.77
Industrial	182	29.12	41.76	29.12
Medical	88	25.0	50.0	25.0
Agriculture	33	27.27	48.48	24.24
Geotextiles	37	37.84	37.84	24.32
Apparel	67	25.37	43.28	31.34
Construction	31	29.03	45.16	25.81

*Note: Many companies crossed into multiple sub-sectors, thus resulting in $\sum n \neq 270$. The total number of companies represented is still 270 for the performance textile industry, however since some companies are present in multiple sub-sectors, they were counted twice, which results in 517 company appearances throughout the seven sub-sectors.

Additionally, totals were calculated for the number of companies that received points for each criterion. Results can be seen in Table 7. As an example, the results from the table read, "Out of 270 companies, 164 companies received

points for their location. Out of 270 companies, 227 received points for having a Website." The points used for this study were previously established in the 2006 "State of the Union" study (Cassill, et al, 2006). The criteria with the largest gaps between points received and points possible were unique products, company growth, participation in a trade show, and connection in the supply chain. These criterions are the areas in which further investigation would be beneficial. It is worth re-investigating these areas to evaluate whether the weights need altered, or whether the criterion is an important factor of competitiveness.

An important note here is that the large gaps, especially in the area of unique products, are based on the criteria established in the 2006 study. Whether a company received points for having unique products actually was determined on the number of markets in which it was present. For instance, a company may cross over into several markets – medical, home furnishings, apparel, hosiery, dyeing, carpeting, outdoor furnishings, accessories, filters, paper – but other companies may be specific to one market. Therefore, a medical company may not fit into multiple categories, which in turn would limit the number of points received for that category. This shows that these number totals may not be relevant to the overall performance textile industry, and also may have changed over the three years since the original data was calculated. Additionally, the original eight criteria were not

split into strategies and tactics. This new research separates the two in order to get a better picture of the differences between strategies and tactics, as well as how performance textile companies view each.

Table 7: Company Points per Criterion

	Location	Website	Growth	Trade	Show	Organization	Unique Products	Supply Chain
Worth	2	1	5	5	3	1	5	4
# Companies receiving points	164	227	61	124	41	82	59	86
Points received weighted	328	227	305	620	123	82	295	344
Total # companies in sector	270	270	270	270	270	270	270	270
Total possible points weighted	540	270	1350	1350	810	270	1350	1080

Points and weights for the entire performance textile industry, as well as each individual sub-sector are plotted in the charts below (See Figures 16-23). Blue lines represent the number of points companies received for each of the eight criteria. Red lines represent the number of possible points companies *could have* received. Percentages earned are also listed to give a clearer picture of the areas

lacking. The criteria with the largest gaps between points received and total possible points are the areas that need the most help and are worth re-investigating.

All Performance Industry: n=270

	Location	Web	Growth	Trade	Show	Organization	Unique Products	Supply Chain
Total points (weighted)	328	227	305	620	123	82	295	344
Total Possible Points (weighted)	538	269	1345	1345	807	269	1345	1076
Percentage Earned	61%	84%	23%	46%	15%	30%	22%	32%

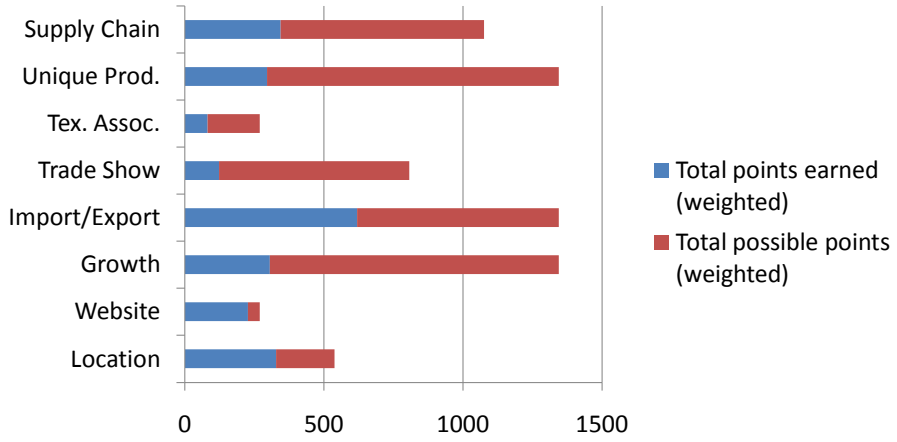


Figure 16: F/C/PV Results for Entire Performance Textile Industry

*Note: For NC Performance textile companies, there is a major "gap" in the area of unique products based on the number of points earned (295) compared to how many points were available (1345). In this category, only 22% of points were earned. Other areas of large gaps include company growth, and participation in a trade show. These results are comparable over all seven sub-sectors.

Agriculture: n=33

	Location	Web	Growth	Trade	Show	Organization	Unique Products	Supply Chain
Total Points (weighted)	52	27	30	50	21	9	15	52
Total Possible Points (weighted)	66	33	165	165	99	33	165	132
Percentage Earned	79%	82%	18%	30%	21%	27%	9%	39%

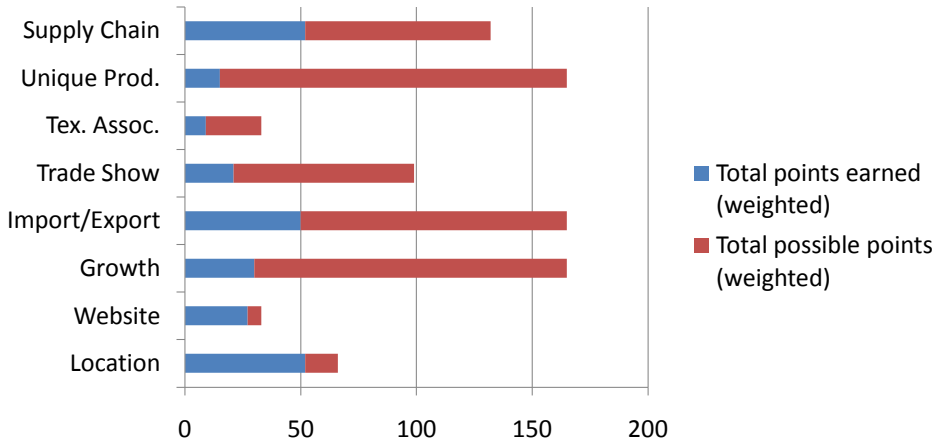


Figure 17: F/C/PV Results for Agriculture sub-sector

Apparel: n=67

	Location	Web	Growth	Trade	Show	Organization	Unique Products	Supply Chain
Total Points (weighted)	104	53	55	105	42	23	70	108
Total Possible Points (weighted)	134	67	335	335	201	67	335	268
Percentage Earned	78%	79%	16%	31%	21%	34%	21%	40%

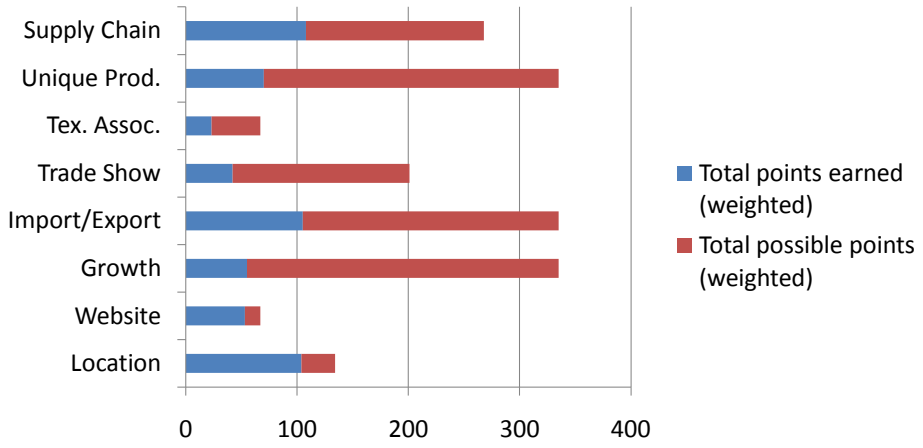


Figure 18: F/C/PV Results for Apparel sub-sector

Construction: n=31

	Location	Web	Growth	Trade	Show	Organization	Unique Products	Supply Chain
Total Points (weighted)	52	26	40	40	21	8	15	48
Total Possible Points (weighted)	62	31	155	155	93	31	155	124
Percentage Earned	84%	84%	26%	26%	23%	26%	10%	39%

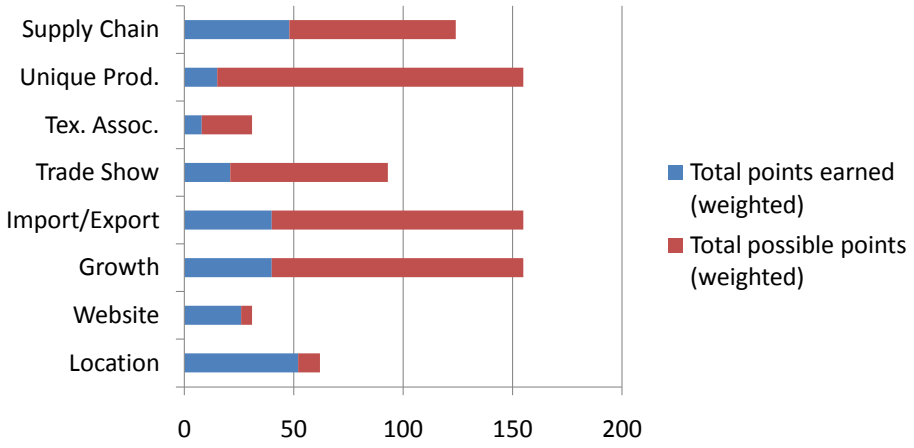


Figure 19: F/C/PV Results for Construction sub-sector

Geotextiles: n=37

	Location	Web	Growth	Trade	Show	Organization	Unique Products	Supply Chain
Total Points (weighted)	52	28	30	45	24	10	20	60
Total Possible Points (weighted)	74	37	185	185	111	37	185	148
Percentage Earned	70%	76%	16%	24%	22%	27%	11%	41%

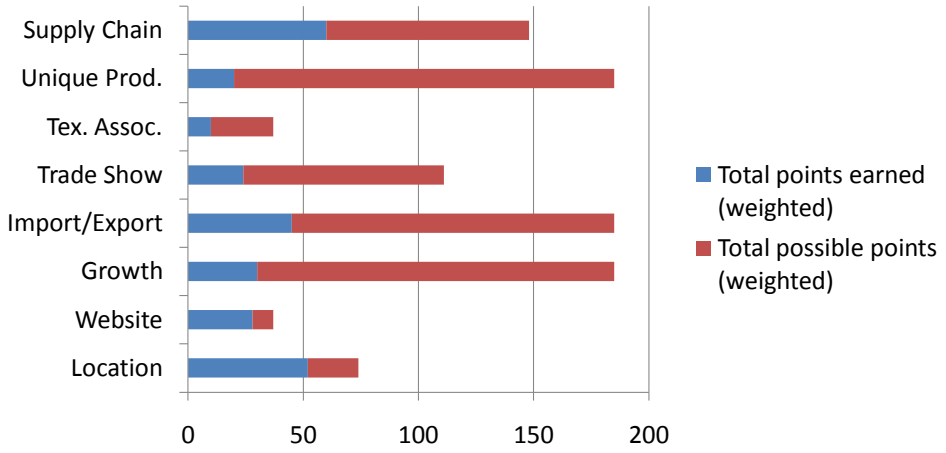


Figure 20: F/C/PV Results for Geotextiles sub-sector

Industrial: n=182

	Location	Web	Growth	Trade	Show	Organization	Unique Products	Supply Chain
Total Points (weighted)	186	137	165	390	81	53	195	144
Total Possible Points (weighted)	364	182	910	910	546	182	910	728
Percentage Earned	51%	75%	18%	43%	15%	29%	21%	20%

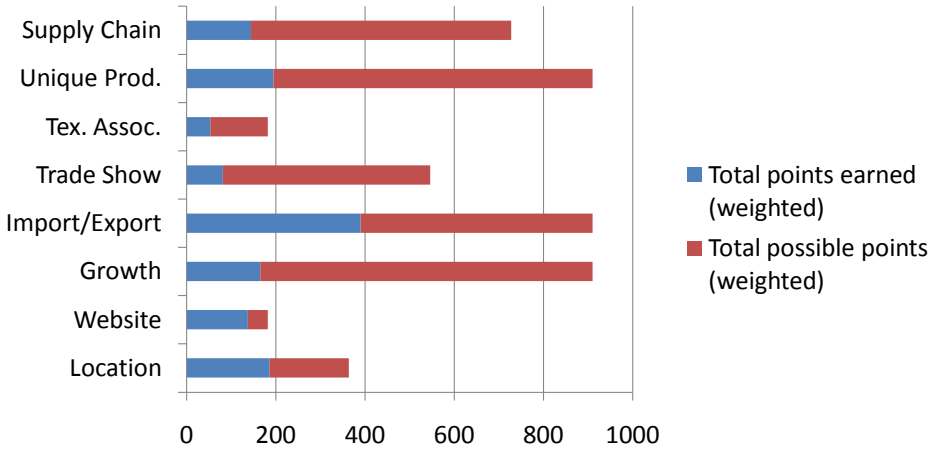


Figure 21: F/C/PV Results for Industrial sub-sector

Medical: n=88

	Location	Web	Growth	Trade	Show	Organization	Unique Products	Supply Chain
Total Points (weighted)	114	72	100	160	48	25	60	108
Total Possible Points (weighted)	176	72	440	440	264	25	440	352
Percentage Earned	65%	100%	23%	36%	18%	100%	14%	31%

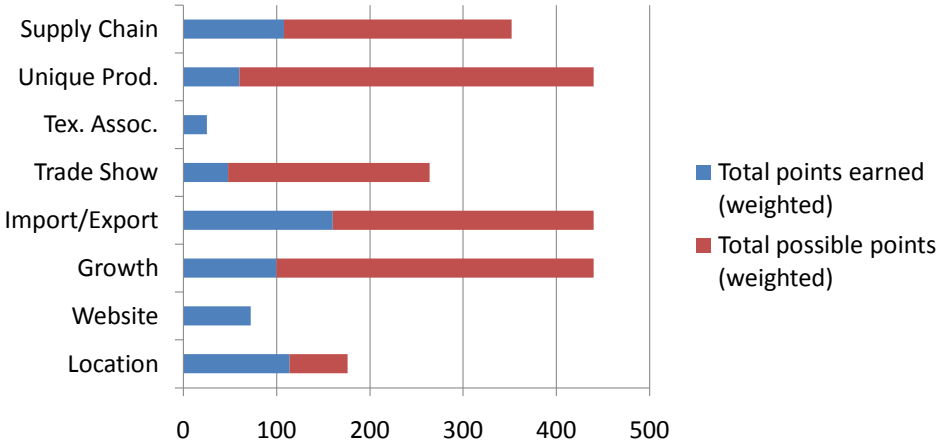


Figure 22: F/C/PV Results for Medical sub-sector

Protection: n=79

	Location	Web	Growth	Trade	Show	Organization	Unique Products	Supply Chain
Total Points (weighted)	98	60	95	150	39	24	65	184
Total Possible Points (weighted)	158	79	395	395	237	79	395	316
Percentage Earned	62%	76%	24%	38%	16%	30%	16%	58%

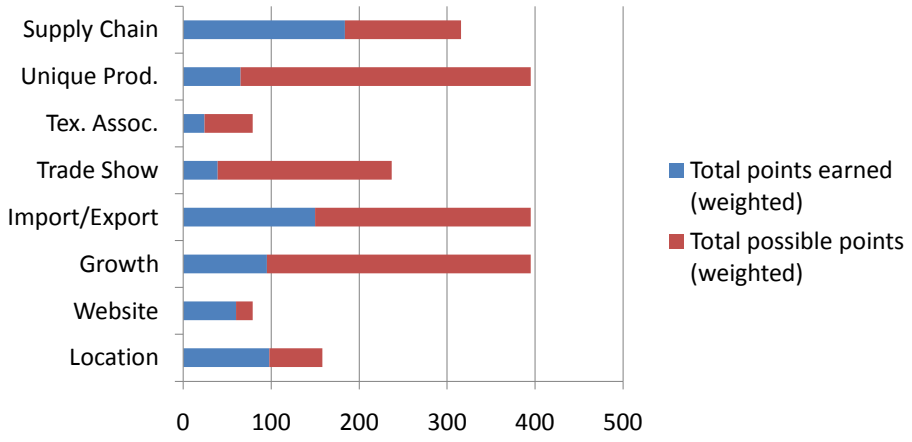


Figure 23: F/C/PV Results for Protection sub-sector

Results from the study showed that of the 270 companies in the performance textile industry, 33% are flourishing, 45% are coping, and 21% are potentially vulnerable. Some companies are associations and organizations that may not relate to the criteria used as weights. Additionally, some companies specialize in a particular niche market. For these examples, the weighting may not have applied, and therefore might have resulted in a lower overall score, thus swaying their F/C/PV standings. This is one limitation of this study;

recommendations for this limitation will be made in Chapter 5. This issue raises the question that perhaps the original eight criteria are not the best indicators of competitiveness for the performance textile industry. The Competitiveness Framework, which is discussed in the next section, and its results show a new mapping of criteria that might better represent the performance textile industry.

Companies in all sub-sectors had the greatest "gap" between earned points and possible points for the criteria of unique products, company growth, participation in a trade show, and connection in the supply chain. Unique products seemed to be the area with the greatest difference in points for all sub-sectors. The gaps may have been influenced by the design of the variables of the original database (a possible limitation of this study). However, these areas, particularly unique products, are the areas that will enhance global competitiveness and allow companies to differentiate themselves. The tools created in this study are useful and helpful for companies to benchmark their progress and re-evaluate current activities, thus leading to greater competitiveness.

The goal is to eventually be able to move all companies five points to the right on the global competitiveness scale. Meaning that adding five additional points to each company's total score would result in a shift of many companies from Potentially Vulnerable into the Coping category, and many of the Coping companies

into the Flourishing category. The following tools presented in this study – the Competitiveness Framework and the Innovation Framework – can be used by companies to help aid in the move to the right.

RO2: To create a competitiveness framework, with which companies can benchmark their competitiveness.

Key Findings:

- "Marketing" and "Raw Material Availability" are the most frequent issues participants placed on the chart.
- "Quality" is the issue placed most frequently in one of the "priority" columns.
- Five new groups identified: Marketing, Material & Supply, Financial, Specification & Quality, and New Products
- Marketing and New Products viewed significantly as strategies; Material & Supply and Finances viewed significantly as tactics; Specification & Quality viewed as both strategy and tactic. These are the new "big strategy areas" and "big tactic areas" that companies should focus on.

A total of 20 data collection instruments were collected from the mailing in July to 212 performance textile companies. Responses from performance textile

company participants were analyzed to see where the indicators were placed on the chart, as well as the frequency of appearances in the “priority” columns (columns 4 and 5). Numbers were summed to reach a total for how many times each indicator was listed as a “strategy,” how many times listed as a “tactic,” and also a grand total of appearances for each indicator. Indicators highlighted in red represent the original eight criteria identified earlier. (See Table 8).

Results showed that there were eight indicators listed as more important than any of the original eight. A few of the original eight even ranked in the bottom half of importance. “Marketing” and “Raw Material Availability” were the two most frequently used indicators. However, “Quality” and “Raw Material Availability” were most frequently placed in one of the “priority” columns (columns 4 and 5). (See Table 9). Table 9 shows the percentages of each indicator being placed in a “priority” column – meaning the most important columns. While an indicator might appear on the chart 10 times, it was listed as a priority 6 of those 10 times, thus resulting in that 60 percent of appearances for that particular indicator were placed as a priority.

Table 8: Performance Indicator Frequencies across Competitiveness Framework

Performance Indicator	# Times Column 1		# Times Column 2		# Times Column 3		# Times Column 4		# Times Column 5		Total Strategy	Total Tactic	Grand Total
	Strategy	Tactic	Strategy	Tactic	Strategy	Tactic	Strategy	Tactic	Strategy	Tactic			
Marketing		1	1		2		9	1	6		18	2	**20**
Raw Material Availability			2		2		2	6	4	3	10	9	**19**
Data		2	3		2	3		5	1	3	6	13	**19**
Product Costs					2	3	1	7	2	3	5	13	**18**
Quality						1	4	3	6	4	10	8	**18**
Customer Specifications	1			1	2	2	3	1	5	3	11	7	**18**
New Products			1	1	2		5		5	3	13	4	**17**
Financing			1	3	3	1	5	1	3		12	5	**17**
Unique Products (5)		1					4	1	8	3	12	5	**17**
Website (1)		2	1		2		5	4	1	2	9	8	**17**
Supplier Proximity	2			3	4	5				2	6	10	**16**
Connection in Supply Chain (4)	1		1			1	6	3	2	2	10	6	**16**
Company Location (2)	1		3	3	3	2	1	2		1	8	8	**16**
Manufacturing	1			2	3	2	3	2	1	2	8	8	**16**
Customer Lead Times			1	2	1	1	1	5	3	1	6	9	**15**
Trade Capabilities (5)	2		1		4		3	2		3	10	5	**15**
Supplier Capabilities				1	2	5	2	3		1	4	10	**14**
Own Technology	1		3		3	2			2	3	9	5	**14**
Compliance		3	1	1	2	3	3			1	6	8	**14**
Design				1	1	2	5	1	3	1	9	5	**14**
Sustainability	3			2	2	2	1	1	1	1	7	6	**13**

Table 8 Continued:

Economic Order Quantities	1	2	1	2	3			4			5	8	**13**
Interest Rates	1	3	2	2		2	1	2			4	9	**13**
Specifications			1	2	2	1	2	4	1		6	7	**13**
Chargebacks	2	4		1		3	1	2			3	10	**13**
Testing	1	1	1	2	1	3	2	1			5	7	**12**
Technology Availability	2			1	1	2	2		1	3	6	6	**12**
Standards	1		2	1	1	2		2	2	1	6	6	**12**
Promotion	3			1		1	1	2	1	2	5	6	**11**
Textile Association (1)	1	3	2	1	1	1		1		1	4	7	**11**
Supplier Certification	1		2	4		2		1			3	7	**10**
Trade Show (3)		1	3	1	1	2	1	1			5	5	**10**
Training and HR	1	1		5	1	1			1		3	7	**10**
Global Perspectives of Business			1			1	3	1	2	1	6	3	**9**
Company Growth (5)			1		4	1	2	1			7	2	**9**
Customer Issues (other)		2	1			1	2		2		5	3	**8**
Supplier Issues (other)	1	3	1	1	1	1					3	5	**8**
Other _____										1	0	1	**1**

Table 9: Percentages of Performance Indicators Listed in Priority Columns

Performance Indicator	Total Strategy of Columns 1-5	Times listed as Strategy Priority (Column 4 or 5)	Percentage listed as Priority	Total Tactic of Columns 1-5	Times listed as Tactic Priority (Column 4 or 5)	Percentage listed as Priority
Marketing	18	**15**	83.33%	2	**1**	50.00%
Raw Material Availability	10	6	60.00%	9	9	100.00%
Data	6	1	16.67%	13	8	61.54%
Product Costs	5	3	60.00%	13	10	76.92%
Quality	10	**10**	100.00%	8	**7**	87.50%
Customer Specifications	11	8	72.73%	7	4	57.14%
New Products	13	10	76.92%	4	3	75.00%
Financing	12	8	66.67%	5	1	20.00%
Unique Products (5)	12	12	100.00%	5	4	80.00%
Website (1)	9	6	66.67%	8	6	75.00%
Supplier Proximity	6	0	0.00%	10	2	20.00%
Connection in Supply Chain (4)	10	8	80.00%	6	5	83.33%
Company Location (2)	8	1	12.50%	8	3	37.50%
Manufacturing	8	4	50.00%	8	4	50.00%
Customer Lead Times	6	4	66.67%	9	6	66.67%
Trade Capabilities (5)	10	3	30.00%	5	5	100.00%
Supplier Capabilities	4	2	50.00%	10	4	40.00%
Own Technology	9	2	22.22%	5	3	60.00%

Table 9 Continued:

Compliance	6	3	50.00%	8	1	12.50%
Design	9	8	88.89%	5	2	40.00%
Sustainability	7	2	28.57%	6	2	33.33%
Economic Order Quantities	5	0	0.00%	8	4	50.00%
Interest Rates	4	1	25.00%	9	2	22.22%
Specifications	6	3	50.00%	7	4	57.14%
Chargebacks	3	1	33.33%	10	2	20.00%
Testing	5	2	40.00%	7	1	14.29%
Technology Availability	6	3	50.00%	6	3	50.00%
Standards	6	2	33.33%	6	3	50.00%
Promotion	5	2	40.00%	6	4	66.67%
Textile Association (1)	4	0	0.00%	7	2	28.57%
Supplier Certification	3	0	0.00%	7	1	14.29%
Trade Show (3)	5	1	20.00%	5	1	20.00%
Training and HR	3	1	33.33%	7	0	0.00%
Global Perspectives of Business	6	5	83.33%	3	2	66.67%
Company Growth (5)	7	2	28.57%	2	1	50.00%
Customer Issues (other)	5	4	80.00%	3	0	0.00%
Supplier Issues (other)	3	0	0.00%	5	0	0.00%
Other _____	0	0	0.00%	1	1	100.00%

Results also showed that the current weights of the original eight criteria may need to be refined. While some of the criteria's weights were validated by participant responses, others were shown to be either too high or too low. Participants agreed that unique products and trade capabilities are critical aspects of competitiveness, however, did not seem to agree that company growth was a critical factor. On the other hand, participants listed having a Website as important. In the 2006 study, "website" was only weighted at 1 point.

Additionally, other performance indicators that were not part of the original eight criteria were identified by participants to hold equal or greater importance than that of the original eight. The top indicators listed by participants include marketing, raw material availability, data, product costs, quality, customer specifications, new products, and financing. These results show that new criteria must be established as the most important factors determining a company's competitiveness. Some factors from the 2006 study that did not have enough consistent data to analyze then, now may play a much larger role in today's economy. New weights need to be distributed among the original eight criteria, as well as adding in some of the other indicators identified as important by the participants for the performance textile industry.

Groups of similar indicators were identified and separated to analyze further. These groups include the key indicators identified by participants from performance textile companies (See Tables 10-14). Five groups were identified:

- Marketing group
- Material & Supply group
- Financial group
- Specification & Quality group
- New Product group

Marketing of performance textiles includes aspects such as Web presence, promoting the product, advertising, and other methods of visibility. This could also include being present at trade shows where the product is being viewed by potential customers. Material and supply areas include aspects such as raw material availability and supplier issues. The proximity of supplier to manufacturer is important in this area, as well as the capability of the supplier to provide the needed product. Financial issues related to performance textiles include product costs, order quantities and interest rates. The state of the economy has a great influence on these aspects and has the potential to greatly change at any given time, which makes this category so important. Specifications and Quality refer to areas such as

standards, certifications, and customer specifications. Because performance textiles are produced mainly for their technical or performance properties, it is critical that specs be followed and standards of quality be met for the end use, especially in areas like medical or military textiles. Finally, new products relates to the differentiated products that companies can produce. This can also refer to the diversity of products from a company, as well as the design elements of unique products.

Table 10: New Performance Indicator Group: Marketing

Marketing Group

Performance Indicator	Column 1		Column 2		Column 3		Column 4		Column 5		Total Strat	Total Tactic	Grand Total
	S	T	S	T	S	T	S	T	S	T			
Marketing		1	1		2		9	1	6		18	2	**20**
Website		2	1		2		5	4	1	2	9	8	**17**
Promotion	3			1		1	1	2	1	2	5	6	**11**
Global Persp. of Bus.			1			1	3	1	2	1	6	3	**9**

Table 11: New Performance Indicator Group: Material and Supply

Material and Supply Group

Performance Indicator	Column 1		Column 2		Column 3		Column 4		Column 5		Total Strat	Total Tactic	Grand Total
	S	T	S	T	S	T	S	T	S	T			
Raw Material Availability			2		2		2	6	4	3	10	9	**19**
Supplier Proximity	2			3	4	5				2	6	10	**16**
Supplier Capabilities				1	2	5	2	3		1	4	10	**14**
Supplier Issues (other)	1	3	1	1	1	1					3	5	**8**

Table 12: New Performance Indicator Group: Financial

Financial Group

Performance Indicator	Column 1		Column 2		Column 3		Column 4		Column 5		Total Strat	Total Tactic	Grand Total
	S	T	S	T	S	T	S	T	S	T			
Product Costs					2	3	1	7	2	3	5	13	**18**
Financing			1	3	3	1	5	1	3		12	5	**17**
Econ. Order Quantities	1	2	1	2	3			4			5	8	**13**
Interest Rates	1	3	2	2		2	1	2			4	9	**13**

Table 13: New Performance Indicator Group: Specification and Quality

Specification and Quality Group

Performance Indicator	Column 1		Column 2		Column 3		Column 4		Column 5		Total Strat	Total Tactic	Grand Total
	S	T	S	T	S	T	S	T	S	T			
Quality						1	4	3	6	4	10	8	**18**
Customer Specifications	1			1	2	2	3	1	5	3	11	7	**18**
Specifications			1	2	2	1	2	4	1		6	7	**13**
Standards	1		2	1	1	2		2	2	1	6	6	**12**
Supplier Certification	1		2	4		2		1			3	7	**10**

Table 14: New Performance Indicator Group: New Product

New Product Group

Performance Indicator	Column 1		Column 2		Column 3		Column 4		Column 5		Total Strat	Total Tactic	Grand Total
	S	T	S	T	S	T	S	T	S	T			
New Products			1	1	2		5		5	3	13	4	**17**
Unique Products		1					4	1	8	3	12	5	**17**
Design				1	1	2	5	1	3	1	9	5	**14**

These groups represent related aspects. Analyzed in their individual groups, new conclusions can be formed. As a whole, the specifications & quality group garnered the most appearances in all columns of the chart with a total of 71 and also had the most appearances in the "priority" columns at the head of the fishbone (column 5) with a total of 42 appearances in columns 4 and 5. This could be interpreted that as a group, specifications and quality are most important. (See Table 15).

Table 15: Comparison of New Cluster Criteria

	All	Strategy	Tactic
Marketing Group	**57**	38	19
Material & Supply Group	**57**	23	34
Financial Group	**61**	26	35
Specs. & Quality Group	**71**	36	35
New Product Group	**48**	34	14

Participants were given definitions of both "strategy" and "tactic" for their reference when filling out the framework. For this study, a strategy was defined as a

goal or plan for competitiveness. A tactic was defined as a *procedure or method of reaching that goal.* Results from the New Cluster Criteria table (Table 15) indicate that five new groupings were discovered. Of the five groups found – marketing, material & supply, financial, specifications & quality, and new products – totals were calculated according to how many times indicators were listed as a strategy and tactic.

From the results, it can be seen that the Specification & Quality group came out on top as receiving the most appearances overall (71 appearances). This indicates that the participants of this study viewed this group as the overall more important area that determines global competitiveness. Additionally, participants viewed specification and quality as being a strategic tool for the company to compete as well as a tactical tool (as indicated in red).

Three "big strategy areas" and three "big tactic areas" were identified (as indicated in red). Marketing and new products were viewed significantly as strategies. Material & supply and finances were viewed mainly as tactics. Interestingly, specs and quality were split rather evenly as both a strategy and a tactic (See Table 15). Conclusions from these results show that these five new groups are the "big things" that matter to performance textile companies. The

original eight criteria identified in the 2006 study can now be replaced by the new five groups identified above.

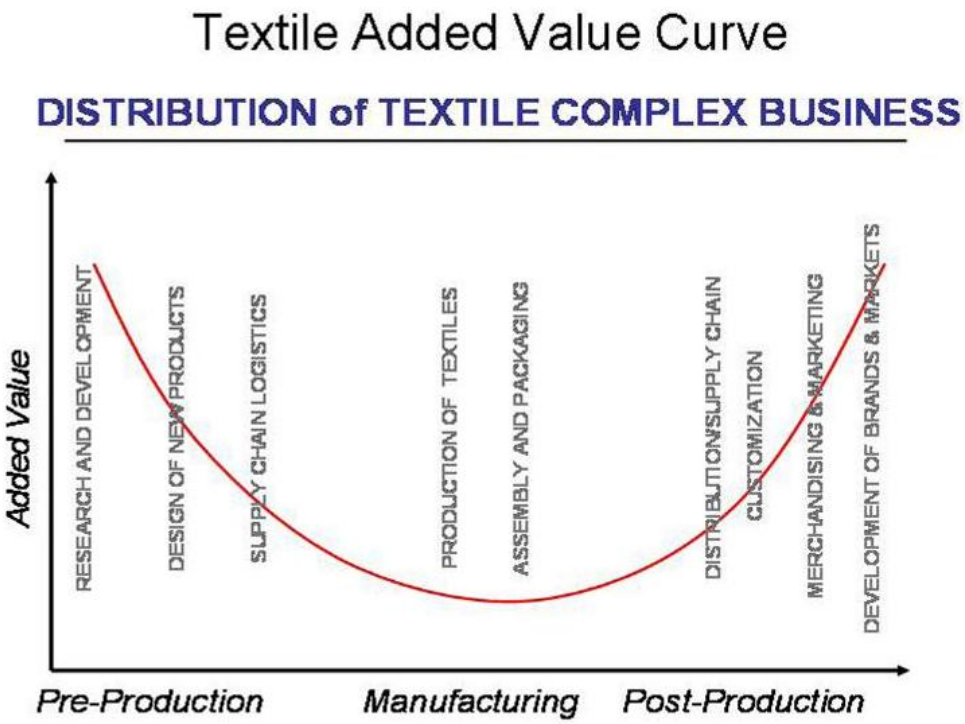


Figure 24: Textile Added Value Curve
Source: Cassill, N; Godfrey, B. and Little, T. (2006). "The New World of Textiles."

The Textile Added Value Curve depicts the areas of value-added processes and activities during each stage of the manufacturing process – pre-production, production, and post-production. There are lower value-added operations in the manufacturing stage. The goal of this diagram is to raise the curve in the manufacturing section by adding more value-added processes and activities.

The five new criteria groups identified above can be used as a method of raising the curve. Strategies and tactics are both important in raising the curve for the performance textile industry. The tactical groups – material & supply, financial, and specification & quality – will be the useful areas to help raise the curve. Most attention needs to be addressed to the front and middle of the curve. Strategic areas, such as the marketing and new product groups from above, come early in the process and are the foundation of the pre-production phase of the curve. Tactical areas will be beneficial in raising the middle (See Figure 25). A combination of both strategies and tactics is the best method of raising the curve. By identifying these new groups of strategies and tactics, the Textile Added Value Curve can be lifted and companies can use the criteria identified to aid their own processes, such as design, development, manufacturing, and marketing performance textile products to the target market.

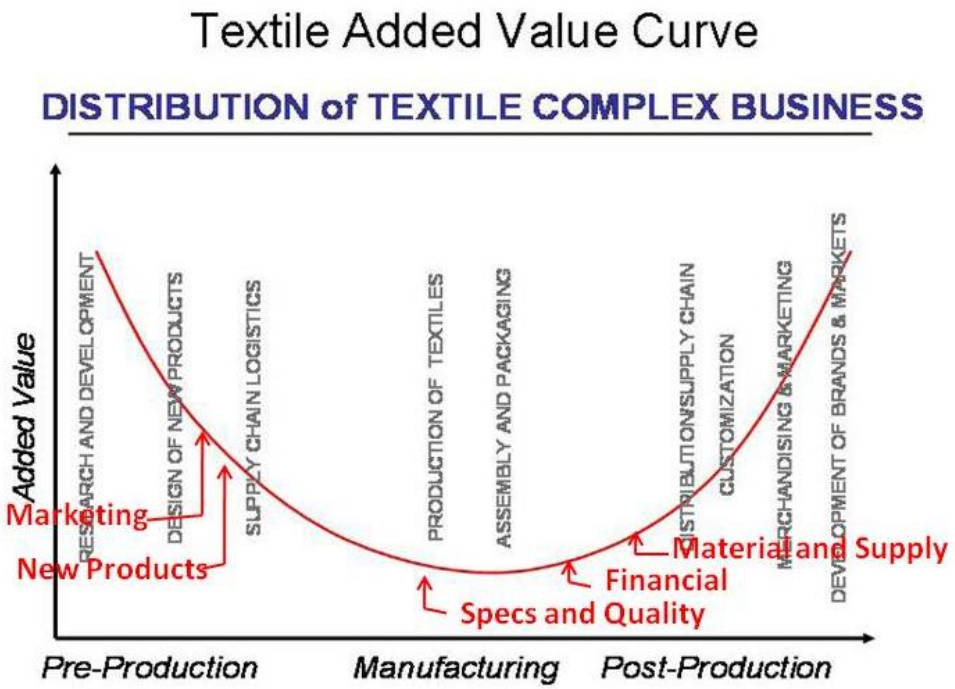


Figure 25: Indicator Groups that will Raise the Textile Added Value Curve
Source: Adapted by Craven (2010) from Cassill, N; Godfrey, B. and Little, T. (2006). "The New World of Textiles."

RO3: To create an innovation framework based upon Moore (2005), which analyzes different innovation types based on 12 classifications across the product lifecycle

Key Findings:

- "Strategy" and "Tactic" indicators most frequently placed in Product Leadership Zone (Refer to Moore's four innovation zones, Figure 3).

- Significant difference found between the Acquisition Zone and all other innovation zones (Refer to Moore's four innovation zones, Figure 3).
- Performance textile companies view innovation as more tactical, and competitiveness as more strategic.
- Performance textile companies place most innovation emphasis on new products, rather than their operations or relationship with customers.

As with the Competitiveness Framework, a total of 20 responses were collected from the large distribution in July. Responses were analyzed in order to determine the distribution of data among the innovation types. The list of 17 attributes was separated into three groups: strategy attributes, tactic attributes, and "gray" attributes (gray referring to an attribute that could be both a strategy *and* a tactic). These three groups were analyzed individually in order to compare the statistical results for each group and find significant differences.

Of the 17 attributes listed on the Innovation Framework, five were considered strategic, eight were considered tactical, and four were considered gray. Determination of whether an attribute was a strategy, tactic, or gray was based on Nelson's fishbone results from her 2008 study, as well as focus group input from the pretest of this study. Results from the SPSS output indicated that there was a

significant difference between the three groups across the Innovation Framework. (See Tables 16-24, blue tables for Strategic attributes, green tables for Tactical attributes, and red tables for Gray attributes).

Table 16: STRATEGIC Attribute Means by Innovation Zone

	N	Mean	Std. Deviation	Std. Error
Product Leadership Zone	20	4.90	3.29114	.73592
Customer Intimacy Zone	20	4.75	3.98517	.89111
Operational Excellence Zone	20	3.10	2.38195	.53262
Acquisition Zone	20	1.05	.82558	.18460
Total	80	3.45	3.22530	.36060

*Dependent Variable: Strategic Attributes (1-20)

Table 17: Analysis of Variance Test for Differences in STRATEGIC Attributes Across Innovation Zones

	Sum of Squares	df	Mean Square	F	Significance (p-val.)
Between Groups	193.50	3	64.5	7.802	.000
Within Groups	628.30	76	8.267		
Total	821.80	79			

*Dependent Variable: Strategic Attributes (1-20)

Table 18: Multiple Comparisons of STRATEGIC Attribute Selection Across Innovation Zones

Zone (I)	Zone (J)	Mean * Difference (I-J)	Std. Error	Sig.
Product Leadership Zone	Customer Intimacy Zone	.15000	1.15571	.999
	Operational Excellence Zone	1.8000	.90844	.215
	Acquisition Zone	3.8500	.75872	.000***
Customer Intimacy Zone	Operational Excellence Zone	1.6500	1.03815	.399
	Acquisition Zone	3.7000	.91003	.003**
Operational Excellence Zone	Acquisition Zone	2.0500	.56370	.007**

*Games-Howell mean-difference tests
**p<.01
***p=.000

Table 19: TACTIC Attribute Means by Innovation Zone

	N	Mean	Std. Deviation	Std. Error
Product Leadership Zone	20	10.00	6.18997	1.38412
Customer Intimacy Zone	20	6.75	5.30020	1.18516
Operational Excellence Zone	20	8.50	6.20272	1.38697
Acquisition Zone	20	1.85	2.13431	.47725
Total	80	6.775	5.98728	.66940

*Dependent Variable: Strategic Attributes (1-20)

Table 20: Analysis of Variance Test for Differences in TACTIC Attributes Across Innovation Zones

	Sum of Squares	df	Mean Square	F	Significance (p-val.)
Between Groups	752.65	3	250.883	9.170	.000
Within Groups	2079.30	76	27.359		
Total	2831.95	79			

*Dependent Variable: Strategic Attributes (1-20)

Table 21: Multiple Comparisons of TACTIC Attribute Selection Across Innovation Zones

Zone (I)	Zone (J)	Mean * Difference (I-J)	Std. Error	Sig.
Product Leadership Zone	Customer Intimacy Zone	3.2500	1.82220	.297
	Operational Excellence Zone	1.5000	1.95946	.869
	Acquisition Zone	8.1500	1.46409	.000***
Customer Intimacy Zone	Operational Excellence Zone	-1.7500	1.82436	.773
	Acquisition Zone	4.9000	1.27764	.004**
Operational Excellence Zone	Acquisition Zone	6.6500	1.46678	.001**

*Games-Howell mean-difference tests
**p<.01
***p=.000

Table 22: GRAY Attribute Means by Innovation Zone

	N	Mean	Std. Deviation	Std. Error
Product Leadership Zone	20	4.10	2.78908	.62366
Customer Intimacy Zone	20	4.55	3.30032	.73797
Operational Excellence Zone	20	3.20	2.80225	.62660
Acquisition Zone	20	.60	.88258	.19735
Total	80	3.1125	2.98941	.33423

*Dependent Variable: Strategic Attributes (1-20)

Table 23: Analysis of Variance Test for Differences in GRAY Attributes Across Innovation Zones

	Sum of Squares	df	Mean Square	F	Significance (p-val.)
Between Groups	187.237	3	62.412	9.144	.000
Within Groups	518.750	76	6.826		
Total	705.988	79			

*Dependent Variable: Strategic Attributes (1-20)

Table 24: Multiple Comparisons of GRAY Attribute Selection Across Innovation Zones

Zone (I)	Zone (J)	Mean * Difference (I-J)	Std. Error	Sig.
Product Leadership Zone	Customer Intimacy Zone	-.45000	.96621	.966
	Operational Excellence Zone	.900000	.88407	.740
	Acquisition Zone	3.50000	.65414	.000***
Customer Intimacy Zone	Operational Excellence Zone	1.35000	.96811	.511
	Acquisition Zone	3.95000	.76391	.000***
Operational Excellence Zone	Acquisition Zone	2.60000	.65695	.003**

*Games-Howell mean-difference tests
**p<.01
***p=.000

To recap Moore's definitions of his four innovation zones, descriptions are listed below:

- *Product Leadership Zone* – includes all scenarios of possible growth (product development, market development, diversification). This zone focuses on creating new products or extending product lines.
- *Customer Intimacy Zone* – focuses on ways to build a better relationship with customers, including through marketing, product experience and enhancements.
- *Operational Excellence Zone* – focuses on improving manufacturing processes through methods such as reducing costs, reducing waste and eliminating non-value adding steps.
- *Acquisition Zone (Category Renewal)* – repositioning resources in the growth category, renewal through merger or acquisition

Results from the Innovation Framework showed that the mean number of strategic responses was highest in the Product Leadership Zone, followed closely by the Customer Intimacy Zone. The mean number of tactic responses was highest in the Product Leadership Zone. Finally, the mean number of gray responses was highest in the Customer Intimacy Zone. This shows that the Operational Excellence

Zone and the Acquisition Zone had the fewest number of responses, and thus could be interpreted as less important in the minds of performance textile companies. Performance textile companies placed the greatest significance in the Product Leadership Zone, which implies that these companies view the innovation of new products as the most important, when compared with their operating processes or building relationships with customers.

The ANOVA model that tested the difference in *strategic* attribute usage across Moore's four zones indicated a significant statistic (F=7.802, df=3, P-val=.000) (See Table 17). In addition, Levene's test of Homogeneity of Variances indicated a significant estimate (Levene=7.067, df=3, P-val=.000). Due to this finding, all post hoc tests for specific differences in *strategic* attribute usage across the four zones are interpreted using the Games-Howell statistic (SPSS, 2010).

The post hoc multiple comparisons tests indicated significant differences between *strategic* attribute usage during the Acquisition Zone and all other zones (See Table 18). Mean differences between *strategic* attribute usage in the Acquisition Zone were predominantly negative: Acquisition Zone/Product Leadership Zone mean difference=-3.85, P-val=.000; Acquisition Zone/Customer Intimacy Zone mean difference=-3.70, P-val<.003; Acquisition Zone/Operational Excellence Zone mean difference =-2.05, P-val<.007. The remaining multiple comparisons did not

indicate significant differences in *strategic* attribute usage among all pairwise comparisons between the Product Leadership Zone, Customer Intimacy Zone, and the Operational Excellence Zone.

The ANOVA model that tested the difference in *tactic* attribute usage across Moore's four zones indicated a significant statistic (F=9.170, df=3, P-val=.000) (See Table 20). In addition, Levene's test of Homogeneity of Variances indicated a significant estimate (Levene=8.411, df=3, P-val=.000). Due to this finding, all post hoc tests for specific differences in *tactic* attribute usage across the four zones are interpreted using the Games-Howell statistic (SPSS, 2010).

The post hoc multiple comparisons tests indicated significant differences between *tactic* attribute usage during the Acquisition Zone and all other zones (See Table 21). Mean differences between *tactic* attribute usage in the Acquisition Zone were predominantly negative: Acquisition Zone/Product Leadership Zone mean difference=-8.15, P-val=.000; Acquisition Zone/Customer Intimacy Zone mean difference=-4.90, P-val<.004; Acquisition Zone/Operational Excellence Zone mean difference =-6.65, P-val<.001. The remaining multiple comparisons did not indicate significant differences in *tactic* attribute usage among all pairwise comparisons between the Product Leadership Zone, Customer Intimacy Zone, and the Operational Excellence Zone.

The ANOVA model that tested the difference in "*gray*" attribute usage across Moore's four zones indicated a significant statistic (F=9.144, df=3, P-val=.000) (See Table 23). In addition, Levene's test of Homogeneity of Variances indicated a significant estimate (Levene=8.855, df=3, P-val=.000). Due to this finding, all post hoc tests for specific differences in *gray* attribute usage across the four zones are interpreted using the Games-Howell statistic (SPSS, 2010).

The post hoc multiple comparisons tests indicated significant differences between *gray* attribute usage during the Acquisition Zone and all other zones (See Table 24). Mean differences between *gray* attribute usage in the Acquisition Zone were predominantly negative: Acquisition Zone/Product Leadership Zone mean difference=-3.50, P-val=.000; Acquisition Zone/Customer Intimacy Zone mean difference=-3.95, P-val=.000; Acquisition Zone/Operational Excellence Zone mean difference =-2.60, P-val<.003. The remaining multiple comparisons did not indicate significant differences in *gray* attribute usage among all pairwise comparisons between the Product Leadership Zone, Customer Intimacy Zone, and the Operational Excellence Zone.

In general, these statistical results show that there is not a direct relationship between the Acquisition Zone and the other three innovation zones on Moore's Innovation Types Curve. The Innovation Framework attempted to identify if there

was a relationship between each of the innovation zones and the number of responses. The statistical results show that the highest number of responses occurred in the Product Leadership Zone, which focuses on new product development. These results are important for performance textile companies because companies can now take the framework and use it to benchmark their own standings. For instance, companies can evaluate whether or not they are placing enough emphasis on new product innovation when compared to the other innovation zones. Companies can check to make sure that they are on track with competitors and competitors' processes by confirming that they are utilizing the appropriate amount of resources for new product innovation (Product Leadership Zone), customer relationships (Customer Intimacy Zone), manufacturing processes (Operational Excellence Zone), and alliances and mergers (Acquisition Zone).

In addition to the statistical data identified from the Innovation Framework, the Innovation Framework and the Competitiveness Framework results can be compared to look for similarities and differences. Five new groupings were identified from the Competitiveness Framework (Marketing group, Material & Supply group, Financial group, Specifications & Quality group, and New Products group). On the Innovation Framework, participants viewed the Product Leadership Zone (which deals with the innovation of new products) as the most significant.

Comparisons can be made about the results from the New Products group from the Competitiveness Framework and the Product Leadership Zone from the Innovation Framework.

The Competitiveness Framework results showed that participants viewed new products as significantly strategic in nature (Refer back to Table 15). However, the results from the Innovation Framework show that participants viewed the new product innovation areas as mostly tactical, with almost 29% of the responses (See Figure 26, area highlighted in Red). The Product Leadership Zone was weighted heavier than the other two zones. The results from the Product Leadership Zone, are opposite from the results of the Competitiveness Framework's five new groupings. This shows that performance textile companies view innovation as highly tactical, but view competitiveness as highly strategic.

		Product Leadership Zone					Customer Intimacy Zone					Operational Excellence Zone					Acquisition Zone	Other		
		Disruptive Innovation	Application Innovation	Product Innovation	Platform Innovation		Line-Extention Innovation	Enhancement Innovation	Marketing Innovation	Experiential Innovation		Value-Engineering Innovation	Integration Innovation	Process Innovation	Value-Migration Innovation				Totals:	
S	Design of Materials	9	9	9	6	33	6	2	5	8	21	6	6	3	5	20			74	247
S	Design for Aesthetics	2	4	7	5	18	6	8	2	6	22	1		1	4	6	3		49	
S	Sustainability	2	2	3	4	11	4	3	5	2	14	3	4	6	3	16	5		46	
S	Compliance	2	4	3	2	11	5	2	3	2	12	4	2	2	4	12	3		38	
S	Need to Enter New Market	5	6	1	4	16	2	5	3	4	14	1			1	2	8		40	
	Totals:	20	25	23	21	89	23	20	18	22	83	15	12	12	17	56	19			
		20/100				89/400					83/400					56/400				
		20%	25%	23%	21%	22.25%	23%	20%	18%	22%	20.75%	15%	12%	12%	17%	14%	19%			
T	Intellectual Property	10	4	2	9	25	1	4	3	9	17	4	2	2	3	11	5		58	481
T	Cost - Meeting target cost	7	8	10	7	32	10	5	4	6	25	10	3	9	4	26	6		89	
T	Traceability - Component trackin	1	1	2	6	10	3	1	1	1	6	4	6	1	2	13	2		31	
T	Technology Availability	9	3	6	6	24	1	3	1	8	13	8	6	5	6	25	4		66	
T	Financial Investment	10	6	6	5	27	4	4	5	5	18	6	6	5	2	19	6		70	
T	Lead Times - Response Time	3	6	5	3	17	3	2	4	3	12	4	4	4	4	16	2		47	
T	Raw Material Availability	5	3	6	11	25	3	1	1	2	7	8	5	4	5	22	1		55	
T	Time to Market	10	6	3	5	24	3	6	8	5	22	6	2	2	5	15	4		65	
	Totals:	55	37	40	52	184	28	26	27	39	120	50	34	32	31	147	30			
		55/160				184/640					120/640					147/640	30/160			
		34.38%	23.13%	25%	32.50%	28.75%	17.50%	16.25%	16.90%	24.38%	18.75%	31.25%	21.25%	20%	19.38%	23%	18.75%			
T or S	Standards	5	3	6	3	17	5	4	4	3	16	6	6	6	1	19	2		54	210
T or S	Certification	3	6	2	6	17	5	6	6	3	20	3	4	4	3	14	2		53	
T or S	End Use Demands	6	7	7	4	24	8	6	5	6	25	4	2		4	10	3		62	
T or S	Design to Specification	1	3	7	4	15	3	5	4	2	14	4	1	3	3	11	1		41	
	Totals:	15	19	22	17	73	21	21	19	14	75	17	13	13	11	54	8			
		15/80				73/320					75/320					54/320				
		18.75%	23.75%	27.50%	21.25%	22.81%	26.25%	26.25%	23.75%	17.50%	23.44%	21.25%	16.25%	16.25%	13.75%	16.88%	10.00%			

Figure 26: Innovation Framework Results and Product Leadership Zone
Source: Craven, 2009.

RO4: To refine and validate previous models and frameworks, or create new models, based on findings of focus group participation and industry survey responses.

Key Findings:

- Competitiveness and Innovation Frameworks can be used as tools by companies to benchmark their own standings.
- Jacobs' and Moore's models show the product lifecycle, including the chasm that products must cross. Results from this study help identify underlying factors that contribute to crossing the chasm.
- Combination of strategies and tactics will best get new innovations successfully to market.

The models used for this study were found to be valid in depicting the product lifecycle and the chasm through which products must cross in order to be successful in the market. Findings from the data collection instruments of this study can be incorporated onto Moore's and Jacobs' models to visually depict the factors that are needed at each stage of innovation (See Figure 27 and 28). The factors listed come directly from the Innovation Framework, and represent the items that participants viewed as the most important attributes related toward new product

innovation. Companies can use this model to visualize the factors related to innovation. Companies can also use the Competitiveness Framework and the Innovation Framework to benchmark their own progress toward global competitiveness and innovation. By observing the results from these frameworks – the ranking of most important indicators (Table 8), and the list of innovation attributes (Figure 26) – companies can make sure that they are incorporating best practices and processes into their business strategies for the future.

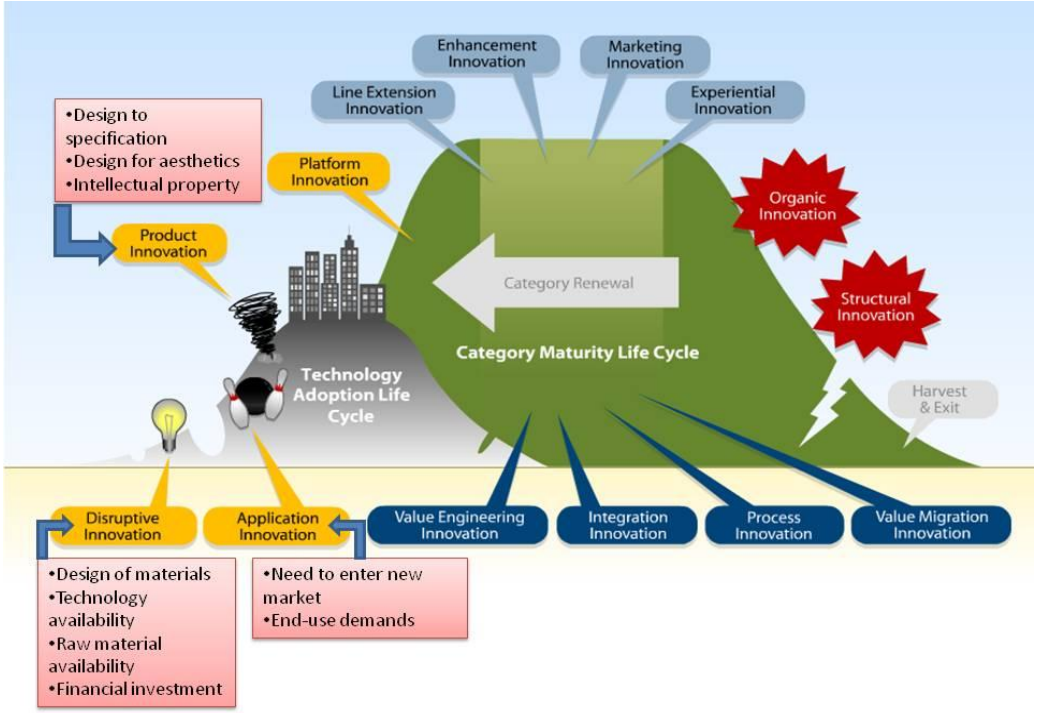


Figure 27: Factors Influencing Moore's Innovation Types
Source: Adapted by Craven (2010) from Moore, G. (2005) Dealing with Darwin: How Great Companies Innovate at Every Phase of Their Evolution. Penguin Group Publishers.

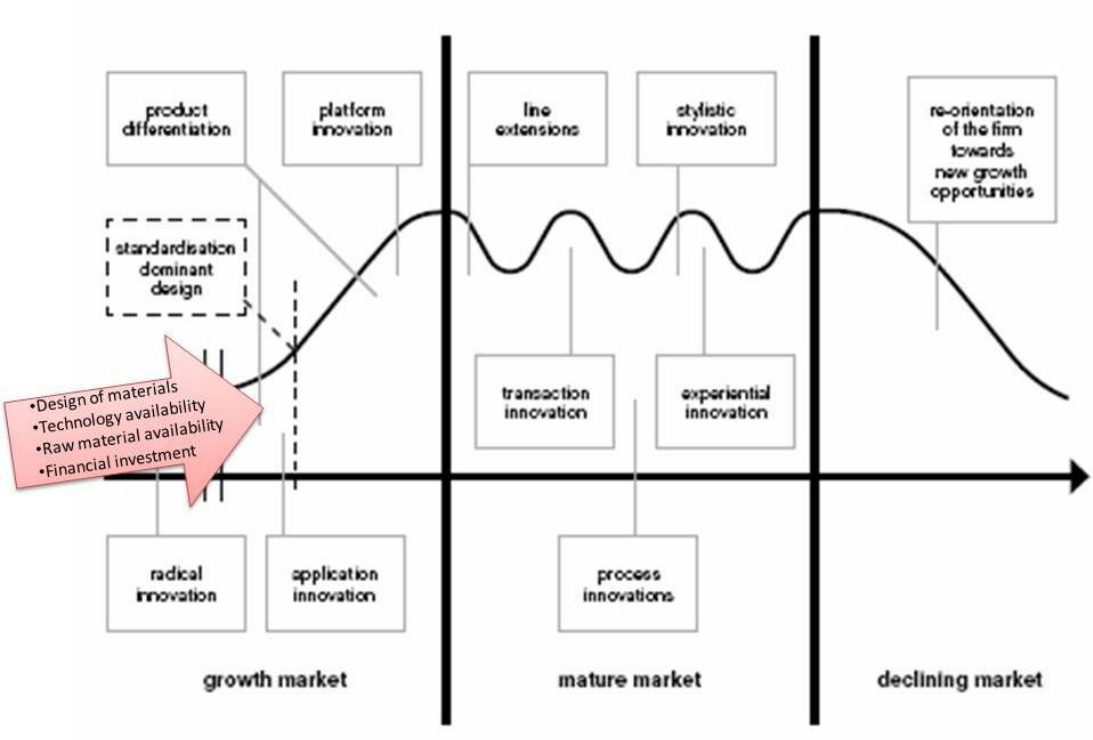


Figure 28: Factors Contributing to Crossing Jacobs' Gate
Source: Adapted by Craven (2010) from Jacobs, D. (2007). *Adding Values: The Cultural Side of Innovation*. Rotterdam: Art EZ Press/Veenman Publishers.

CHAPTER V

CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

Summary

The purpose of this research was to build a Competitiveness Framework and Innovation Framework, with which performance textile companies can use to benchmark their productivity and innovation. Another purpose of this research was to analyze the current standings of North Carolina performance textile companies. Companies were to be classified into categories of Flourishing, Coping, and Potentially Vulnerable. A goal of the study was to be able to help move all companies "five points to the right" on the competitiveness scale.

The conceptual models used in this study provided a structure for analyzing and applying global competitiveness and new product innovation. Innovation is a critical part of new product success and company competitiveness. Models used in this study included Dany Jacobs' *Lifecycle of Innovation* (Jacobs, 2007), Geoffrey Moore's *Types of Innovation Curve* (Moore, 2005), and the *Textile Added Value Curve* (Cassill, et al, 2006). Each of these models was used to examine innovation and its significance to competitiveness. According to Moore's *Types of Innovation Curve*, there are four significant innovation zones, each containing several types of innovation throughout the product lifecycle.

The methodology used in this research was a four-part approach to address the research objectives of this study. Part I consisted of the analysis of North Carolina's performance textile companies current standings and classification into three performance categories. Part II addressed global competitiveness and focused on the development of the Competitiveness Framework. Part III consisted of creating the Innovation Framework and analyzing market entry strategies and tactics to aid companies in crossing the "chasm." Finally, Part IV focused on refinement of the frameworks and development of new, revised models based on feedback and input from industry participants.

The study of new product innovation and "Jacobs' gate" will be beneficial to companies in order for them to increase productive activities within their business units. By producing more successful new products, companies will continue to become more globally competitive. The results of this study show what it takes for new products to successfully make it through the gate and into market. The value of this discovery will not be limited to the performance textile industry alone. Instead, the results can be used by many industries in order to improve their processes and increase the number of successful innovations.

Summary of Results

The following summary of results relates directly to the research objectives of this study:

1. **To analyze the North Carolina performance textile industry's global competitiveness by benchmarking companies' performance based on the criteria from the 2006 "State of the Union" study, and by categorizing companies into performance levels based on points acquired.**

North Carolina is the number one state for textile manufacturing, including yarn and fabric (Godfrey, 2009). Since 2003, there have been 226 new or expanded textile companies in North Carolina (Godfrey, 2009). The Performance Textile industry in North Carolina is a significant market for the state. Of the approximately 270 performance textile companies competing in North Carolina, the majority of companies are performing at a flourishing or coping level. Results from the study showed that of the 270 companies in the performance textile industry, 33% are flourishing, 45% are coping, and 21% are potentially vulnerable. An important observation is that the entire North Carolina textile industry was found to be 39% Potentially Vulnerable, but the Performance Textile industry is only 21% Potentially Vulnerable. This shows that, in general, performance textile companies are performing better than non-performance companies. Because the entire textile

industry is 20% more Potentially Vulnerable than the performance textile industry, it can be assumed that performance textile companies are more able to fulfill the criteria from the 2006 database to receive points. The criteria with the largest gaps between points received and points possible were unique products, company growth, participation in a trade show, and connection in the supply chain. These criterions are the areas in which further investigation would be beneficial. Additionally, the original database should be analyzed to refine the criteria used to rank companies.

2. To create a competitiveness framework, with which companies can benchmark their competitiveness, through focus group and data collection instruments

"Marketing" and "Raw Material Availability" were the two most frequently used indicators. However, "Quality" and "Raw Material Availability" were most frequently placed in one of the "priority" columns (columns 4 and 5). Groups of similar indicators were identified and separated to analyze further. Five groups were identified: Marketing group, Material & Supply group, Financial group, Specification & Quality group, and New Product group. As a whole, the specifications & quality group garnered the most appearances in all columns of the chart with a total of 71 and also had the most appearances in the "priority" columns at the head of the fishbone (columns 4 and 5) with a total of 42 appearances.

This indicates that the participants of this study viewed specifications and quality as the overall more important area that determines global competitiveness. Three "big strategy areas" and three "big tactic areas" were identified. Marketing and New Products were viewed significantly as strategies. Material & Supply and Finances were viewed mainly as tactics. Interestingly, Specs & Quality were split rather evenly as both a strategy and a tactic. These "big areas" include the indicators that are most important to achieving global competitiveness. This means that performance textile companies should utilize a combination of the strategies and tactics identified to achieve competitiveness (Refer back to Figures 9-13).

3. To create an innovation framework based upon Moore (2005), which analyzes different innovation types, through focus group and data collection instruments

Of the 17 attributes listed on the Innovation Framework, five were considered strategic, eight were considered tactical, and four were considered gray. Results showed that the mean number of strategic responses was highest in the Product Leadership Zone. The mean number of tactic responses was highest in the Product Leadership Zone. Finally, the mean number of gray responses was highest in the Customer Intimacy Zone. This means that performance textile companies regard new product innovation more importantly than customer relationships and

efficient processing. The ANOVA model that tested the difference in strategic, tactical and gray attribute usage across Moore's four zones indicated a significant statistic. The post hoc multiple comparisons tests indicated significant differences between strategic, tactical and gray attribute usage during the Acquisition Zone and all other zones. Additionally, comparisons of the results from the Innovation Framework with the results of the Competitiveness Framework showed that participants viewed innovation as more tactical and competitiveness as more strategic. These statistics are important for performance textile companies because companies can now take the framework and use it to benchmark their own standings. For instance, companies can evaluate whether or not they are placing enough emphasis on new product innovation when compared to the other innovation zones, as a way to stay in line with competitors.

4. **To refine and validate previous models and frameworks, or create new models, based on findings of focus group participation and industry responses from the data collection instruments**

Both models were validated and new groupings were formed to refine the views and input of participants. From the Competitiveness Framework, five new groupings were formed to represent the new "big" areas of interest. From the Innovation Framework, the Product Leadership Zone was highlighted as a significant

aspect of new product innovation. This zone would be an important area to continue future research. Findings from the data collection instruments of this study can be incorporated onto Jacobs and Moore's models to visually depict the factors that are needed at each stage of innovation (Refer back to Figures 27 and 28). The new "big" areas of interest can also be incorporated onto the Textile Added Value Curve to show which areas will be beneficial to raise the curve (Refer back to Figure 25).

Limitations

There are six limitations to this research study:

- *Definitions of the original eight criteria* – Some of the original eight criteria are vague, subjective, and difficult to measure. For instance, criteria such as "growth" and "unique products" may mean one thing to one company and something completely different to another company.
- *Database used to allocate points* – the database established in the 2006 "State of the Union" study (Cassill, et al, 2006) includes associations and organizations that may not relate to the criteria used as weights for this study. Low scores may have resulted for this reason, which may have

swayed F/C/PV standings. The performance textile industry is different for the purposes of this study compared to the 2006 study.

- *Sampling method* – A convenience sample of North Carolina companies was used and participating companies were identified by the researcher and College of Textiles faculty. Therefore, the study's results are a generalization of the performance textile industry in North Carolina, and cannot be generalized to the population, rather only to the sample.
- *Sample size of the study* – The response rate for this study was relatively small at 10.5%. One possible reason is that 89% of textile companies in NC are privately held, which may have influenced the response rate of the distribution materials due to the fact that many companies are reluctant to release private company information regarding their practices and processes.
- *Data collection method* – The data collection instruments were sent through the mail, instead of potentially faster and easier methods, such as the Internet or an online format. This could have affected the response rate because of the time it took to complete the physical

documents, as well as the hassle of mailing the documents back to the researcher.

- *Innovation Framework Design* – The Innovation Framework's design did not include separate independent variables to be statistically analyzed. For this reason, analyses such as Chi Square tests could not be run on the data.

Recommendations

Industry:

The United States is still a very key player in the global textile industry and has the capabilities to compete on an international level. North Carolina textile companies must make sure suppliers are innovative and understand consumer demands, as well as understand the newest performance technologies – all of which were identified as significant performance indicators on the Competitiveness Framework. Companies must know the competition, including the competitive environment, competing companies, and market dynamics, including opportunities for product differentiation and niche markets. Plans should be developed for assisting existing companies and recruiting new companies to the state. Struggling companies and new companies should use the frameworks developed in this study

to assess their own standings in the industry, as well as what they need to improve to succeed in competitiveness and innovation.

Perhaps the biggest take-away from this study is that the frameworks and tools developed were designed specifically for companies to use for their own self-assessment. Companies can use the findings of this study to determine where they are struggling and to re-evaluate current practices. The strategies and tactics identified should be applied to companies to help increase productivity and overall competitiveness.

Future Research:

Performance textile companies in North Carolina should continue to be targeted for further development in the areas of competitiveness and innovation. These areas are the key drivers for successful companies, and for companies to be able to compete on a global level. Opportunities lie in the areas of strengthening the performance textile sector in the state. Awareness of specialty or niche markets within the industry is important to retain companies and jobs in North Carolina. Helping bring information about innovation and other competitiveness drivers, such as the results found from both frameworks in this study, to companies will aid in global expansion.

Further refinement and development of the Competitiveness Framework and the Innovation Framework will help aid companies in those fields. The following recommendations for refining the frameworks in this study will be beneficial for future research.

- Narrowing the Competitiveness Framework to consist of only the top three columns (eliminating columns 1 and 2 on the framework). This will make the framework more specific and can zone in on the most important indicators of competitiveness. Narrowing to three columns might also make the framework easier for companies to use and complete for future research.
- Expanding the list of performance indicators and attributes for both the Competitiveness Framework and the Innovation Framework. Having more substantial focus group input into creating these lists would be useful to better understand the exact issues facing the industry.
- Developing a more specific Innovation Framework that narrows in on the Product Leadership Zone – the zone that focuses primarily on new product innovation. Participants of a future study might find the

framework easier to complete if it were more simplistic and narrowly focused. Other research into operational excellence and customer relationships of performance textile companies would benefit from the analysis of Moore's second and third innovation zones.

- Redesigning the Innovation Framework to include two independent variables would be beneficial in order to run more statistical tests, such as a Chi Square test, which could not be run on the current design of the Innovation Framework. A different design of the framework might allow for additional tests comparing other aspects of the framework.

As mentioned previously, the performance textile industry confuses strategies and tactics. It is important for companies to know and understand the difference between strategies and tactics because they are used differently to achieve goals and objectives. For instance, some of the new "big" areas identified in this study were found to include mostly strategic factors, while other areas are mostly tactical. Knowing the difference and utilizing each to the fullest potential can make a significant difference in a company's global competitiveness and new product innovation. Holding workshops to explain the difference between strategies

and tactics, as well as how each can be used to enhance companies' competitiveness would be worthwhile. One of the findings from the Competitiveness and Innovation Frameworks was that participants viewed innovation as more tactical and competitiveness as more strategic. This is a key area for future research, especially in understanding why companies view these areas the way they do.

Additionally, supporting organizations, such as the North Carolina Department of Commerce, can use "success stories" from Flourishing companies as a model for others in the State. Industry-wide standards and definitions of strategies, tactics, and performance indicators will make the industry more cohesive and able to utilize the appropriate activities to its benefit. By having straight-forward definitions of strategies and tactics, companies can make sure that they are using each properly and to the fullest. Finally, North Carolina must recruit more experts in the field of performance textiles who are able to lead companies toward success. Retaining strong companies in the state, as well as recruiting new companies will help keep the performance textile industry remain strong North Carolina. The frameworks presented in this study should be used by new and old companies alike to aid in greater innovation and competitiveness.

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APPENDICES

Appendix A: Focus Group Materials
Agenda: A1

Performance Textile Focus Group
March 12, 2009
9 a.m. to 1 p.m.
College of Textiles – Room 3436
Agenda
"Building the Performance Textile Competitiveness Framework: New Product Innovation Strategies and Successful Market Entry"

9:00 – Introductions
- Review agenda: purpose of focus group and expected results
- Introduce NCSU members and focus participants

Benchmarking Competitiveness and Innovation
9:30 – Competitiveness
- Define and identify methods of how to compete
- Build a competitive framework

10:00 – Benchmarking
- Market data, import/export data
- Identify what is missing for companies to benchmark themselves

10:30 – Break

Product Innovation
10:40 – New product development: customer or supplier driven
- Product lifecycle management
- Performance textiles entry barriers
- How to evaluate new product potential for success

11:30 – Lunch

12:00 – Action items

12:30 – Wrap-up
- Re-evaluate and refine framework
- Future strategies

Invitation Letter: A2

February 20, 2009

Dear _____,

North Carolina State University's College of Textiles is conducting an on-going study that focuses on the performance textile industry. Performance textiles are materials and products manufactured primarily for their technical and performance properties in addition to their aesthetic or decorative characteristics.

The study, which is funded by the North Carolina Department of Commerce, focuses on the criteria that aid companies in their global competitiveness. Such key criteria include trade, connection in the supply chain, and unique products. Innovation of new products and the measures that contribute to the product's success are also important factors of competitiveness.

Your company has been recognized as an important producer and/or marketer in North Carolina's performance textile industry. For that reason, we would like to extend an invitation for you to participate in a focus group at the College of Textiles on **Thursday, March 12, 2009, from 9 a.m. until 1 p.m.**

Topics to be discussed will include new product innovation, value-adding strategies, overcoming market entry barriers, product lifecycle management, as well as additional performance textile issues. The goal of the focus group will be to identify problems and opportunities, and formulate strategies that can aid companies in competitiveness. By participating, your company can build a framework for benchmarking a performance textile company's mobilization for competitiveness. Interacting with other textile industry members will help identify both positive and negative factors that contribute to competitiveness. Additionally, your company will have access to the study's findings after its completion.

We hope that you will consider participating in this focus group. It is important for your company to be represented and we hope that you or another company representative will be able to join us.

Please confirm your company's participation and the identification of the attending member via e-mail by Monday, March 2, 2009. All correspondences should be directed to Jennifer Gildea, jegildea@ncsu.edu. A detailed agenda and logistic information will soon follow.

Thank you for your time and consideration in participating in this study.

Regards,

Jennifer Gildea, Graduate Research Assistant
Nancy Cassill, Professor and Department Head, Textile and Apparel Technology and Management
Blanton Godfrey, Dean of the College of Textiles
Trevor Little, Professor

Logistics E-mail: A3

March 9, 2009

Thank you for agreeing to participate in the performance textile focus group, **Thursday, March 12, 2009 from 9 a.m. to 1 p.m. at the College of Textiles in room 3436**. This focus group is part of a research study funded by the North Carolina Department of Commerce, and the aim is to identify criteria that aid companies in their global competitiveness, including new product innovation.

The focus group will consist of guided questions of textile-related topics, including new product innovation, value-adding strategies, overcoming market entry barriers, and product lifecycle management. Outcomes of the focus group will include identifying problems and opportunities, formulating strategies that can aid companies in competitiveness, and building a framework for benchmarking a performance textile company's mobilization for competitiveness.

The focus group will begin promptly at 9 a.m. Parking is available in the Textile Visitor parking lot in front of the College of Textiles, and a parking permit will be issued to you on arrival.

Attached you will find directions to the College, a list of participants, as well as an outline of the focus group agenda and topics.

If you have any further questions or concerns, please contact Jennifer Gildea, jegildea@ncsu.edu. Also, if you have any questions of problems on March 12, please call Jennifer at (814) 720-0074 or Rob Cooper at (919) 515-6632.

Thank you in advance for your participation – we look forward to seeing you next Thursday.

Regards,

Jennifer Gildea, Graduate Research Assistant
Nancy Cassill, Professor and Department Head, Textile and Apparel Technology and Management
Blanton Godfrey, Dean of the College of Textiles
Trevor Little, Professor

Invite List: A4

Company	Name	Email
Glen Raven	Patrick Bell	hbates@glenraven.com
Quantum Group	Jeff Bruner	jbruner@quantum5280.com
	John Wilson	jtuu@msn.com
Invista	Larry Williams	
Radici Spandex Corp	Marty Moran	mmoran@radicispandex.com
	Kim Hall	khall@radicispandex.com
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Precision Fabrics Group Inc	Joe Capobianco	joe.capobianco@precisionfabrics.com
American and Efird Inc	Morris Dellinger	
	Mark Hatton	mark.hatton@amefird.com
Unifi Inc	Roy Gibson	rgibson@unifi.com
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DuPont	Barbara Knight	barbara.g.knight@usa.dupont.com
Hornwood Inc	Kenny Horne	hwd@hornwoodinc.com
McMurray Fabrics Inc	Johnathan Yoder	
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Carolina Narrow Fabrics Co	Horace Freeman	customerservice@carolinanarrowfabric.com
Stowe-Pharr Mills Inc	J.M. Carstarphen	
Wellman Inc	Sam Cawa	sam.cawa@wellmaninc.com
Shaw Industries Inc	Bob Belden	
General Elastic Corp	James Kenall	
Domestic Fabrics Corp	Fred Hunneky	domestic@domesticfabrics.com
	Bill Hunneky	BillH@domesticfabrics.com
Performance Fibers Inc.	Greg Rogowski	
NC Dept. of Commerce	Tammy Lester	tlester@nccommerce.com
	Glenn Jackman	gjackman@nccommerce.com
	Keith Crisco	

Participant List: A5

Company	Name	Email
Parkdale Mills	Doug Woolweaver	Dougwoolweaver@parkdalemills.com
	Dick June	djune@parkdalemills.com
Quantum Group	John Wilson	jtuu@msn.com
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NC Dept. of Commerce	Tammy Lester	tlester@nccommerce.com
	Glenn Jackman	gjackman@nccommerce.com
NCSU	Trevor Little	Trevor_little@ncsu.edu
	Jennifer Gildea	jegildea@ncsu.edu

Thank-You E-mail: A6

Thank you for attending the NC State College of Textiles' Performance Textile Focus Group. Your participation was vital to the success of the research project, *Building the Competitiveness Framework.*

We sincerely appreciate you taking time out of your busy week to attend the focus group. Thank you for your time, honesty, and opinions. Please let us know if we can provide your company any additional information or resources.

We look forward to sharing the final results of the study with you next spring.

Best Regards,
Jennifer Gildea

Appendix B: Data Collection Instruments
E-mail Notification: B1

Hello _____,

North Carolina State University's College of Textiles, in collaboration with North Carolina Department of Commerce, is conducting a research study of the performance textile industry in North Carolina. The goal of the study is to create a framework for global competitiveness and new product innovation.

Your company has been recognized as an important factor in this industry and we would love to have your participation in the study. A packet of materials will be mailed to your company within the next week, containing tools that we will analyze to create the final frameworks.

Your contribution to the study is greatly appreciated. We look forward to seeing the final outcome of the study, which will be shared with all participating companies.

Best Regards,

Jennifer Craven and Dr. Trevor Little

Distribution List: B2

Company Name	Contact	Email
3M Company	Tony Aulisa	
A S C International	Jeannette Fragola	jfragola@ascinternational.us
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Carpenter Company	Will Robbins	
Catalog Products, Inc	Bob Deerin	rdeerin@msn.com
CCP Industries	Ken Wilson	kwilsonccp@earthlink.net
CEM Corporation	Michael Howe	michael.howe@cem.com
Century Hosiery Inc	Malcolm Martin	mmartin@centuryhosiery.com
Charter Medical Ltd., A Lydall Company	Martha Quarles	MQuarles@lydall.com
Clariant Corporation	Connie Knight	connie.knight@clariant.com, ken.golder@clariant.com
Coats North America		
Colbond Inc	Bart Austin	bart.austin@colbond.com, don.brown@colbond.com
Combeau Industries	Brian Rosenstein	brianr@tsgfinishing.com
Correct Nonwovens Corporation	Babette A Bedell	
Cotton Inc	Janet O'Regan	joregan@cottoninc.com
Credible Technologies Inc	Dennis Younger	
Cronatron Welding Systems, Inc.		infro@cronatronwelding.com
DAK Americas	Allan Block	ablock@dakamericas.com

Dalco Nonwovens	Mark Evans	markevans@dalcononwovens.com
Dalure Fashions	Dawn Eure	
Deep River Mills Coated Fabrcs	Larry Booth	lbo.booth@gmail.com, booth.vicki@gmail.com
Dillon Supply Company	Shelton Coley	
Domestic Fabrics Corp	Fred Hunneky	domestic@domesticfabrics.com, BillH@domesticfabrics.com
Domnick Hunter, Inc.	Jane Sexton	jane.sexton@domnickhunter.com
Drum Filter Media	JC Hollinger III	drumfiltermedia@aol.com
DSM Dyneema	Randy McGowan	
DuPont	Barbara Knight/Scott Harding	barbara.g.knight@usa.dupont.com
E M Threads Inc	Deirdre Connellan	deirdre.connellan@
EAT inc	Oliver Meier	eatinc@eat-kempen.de
Elder Hosiery Mills Inc	Delos Elder	delos@elderhosiery.com
Engineered Textile Resources	Michael Byles	mbyles@etrfabrics.com
Enventys	Louis Foreman	louis.foreman@enventys.com
Fabric Sources International	Thomas S. Cansler	tcansler@buyfsi.com
Faith Packaging	Glenn Rich	
Fiber Cushioning Inc	Melissa Hunt	
Fiber Dynamics Inc-Engineered Nonwovens	Jim Heery	jah@fiberdyninc.com
Filtex Inc (O'mara Inc)	Chris O'Mara	comara@omarainc.com
Filtration Technology Inc	Scott Matthews	mike@filtrationtechnology.com
Flanders Filters Inc.	Tommy O'Neal	toneal@flanderscorp.com
Foamex International Inc	Carroll Galliher	
Freudenberg Nonwovens North America	Terry O'Regan/Russ Johnson	terry.oregan@fvna.com, russ.johnson@freudenburg-nw.com
Frontier Spinning Mills LLC	John Riddle	john.riddle@frontierspinning.com
General Elastic Corp	James Kendall	
Glen Raven Technical Fabrics (Sunbrella)	Matt Clark/Hal Hunnicutt	matt.clark@glenraven.com, hhunnicutt@glenraven.com
Greene Natural Fibers	Bert Nimmo	
Hanes Geo Components (Webtec)	Bobby Starling	bobby.starling@hanescompanies.com

Hanes Industries Inc	Tim Allen	tim.allen@hanesindustries.com
HanesBrands	Richard A. Noll	
Hendersonville Tent Co Inc	Steve Bishop	hvillet@bellsouth.net
Hexion Specialty Chemicals Inc	Eric Ogles	
Hickory Springs Mfg. Company	Mike Day	rcfrazier@hickorysprings.com
Hollingsworth & Vose Company	Art Whitmeyer	
Hornwood Inc	Kenny Horne	hwd@hornwoodinc.com
Horseware Triple Crown Blanket	Rachel Mashburn	info@triplecrowncustom.com
Hosiery Technology Center	Dan St. Louis/Dean Allred	sockman@legsource.com, dallred@legsource.com
Huber Textiles Inc	Steven Huber	hutextiles@aol.com
Huesker Inc.	Steve Lothspeich	slothspeich@hueskerinc.com
INDA	Rory Holmes	rholmes@inda.org
Independent Linen Service Inc	Gene Brannon	ind_linen@vnet.net
Industrial Laboratory Equipment Company Inc.	Harry Simmons	ile@ile-textiles.com
Industrial Microwave Systems	Howard Laffler	sandra.ross@industrialmicrowave.com
Ingle Protective Systems Inc	Dean Andrews	
Innovatech Inc.	H S Crouch	admin@novafilter.com
Interstate Narrow Fabrics Inc	Tony Vailati	
Intex Corp	Lori Anden	loria@intexcorporation.com
Invista	Larry Williams	larry.williams@kosa.com
ITG (Burlington, Cone, Carlisle, Nano-tex)	Joseph Gorga	gorga.joe@burlington.com
J G Thompson Enterprises	John Garry Thompson	
J. E. Herndon Company	J.E. Herndon	jherndon@jeherndon.com, wherndon@jeherndon.com
Jacob Holm Group	Michael Norboge	michael.norboge@jacob-holm.com, mno@jacob-holm.com
JHRG LLC	John Holland	jholland@hsarmor.com

John Plant Co Inc	Robert Jarman	jarman@johnplant.com
JPS Elastomerics (Dow Geomembranes)	Andy Smith	
JSL Partners, Inc.	John Merlini	jmerlini@jslpartners.com, John@jslpartners.com
Ken Smith Yarn Company	Ken Smith	
Kimberly-Clark Corporation	Tom Mildenhall, Ph.D.	tmildnhl@kcc.com
Kruss USA	James Chamberlain	jrc@krussusa.com
Lampe USA Inc.	Peter Schoubben	peterschoubben@lampeusa.com
Leesona Division	Robert Clark	rclark@leesonallc.com
Leggett & Platt Inc	Bill Cruse	bill.cruse@leggett.com
Logitex	Joel Elam	sales@logitexllc.com
Longworth Industries (PolarMax)	Randy Black	rblack@longworthind.com
Loomcraft Textiles	Mark Mehler	mmehler923@gmail.com
Lydall Thermal/Acoustical Group	Joseph Wilstd	
Maag Pump Systems Textron	David Jewell	DavidJewell@maag.com
Mallard Creek Polymers	Dan Neri	dneri@mcpolymers.com
Martin Mills/Fruit of the Loom	Wayne Brooks	
Mauney Hosiery Mills Inc	Kemp Mauney	kmauney@aol.com
Mayer Textile Machine Corp.	Barry Kelly	bkelly@karlmayerusa.com
McMichael Mills Inc	Dalton McMichael	donald@mcmichaelmills.com, haroldr@mcmichaelmills.com
McMurray Fabrics Inc	Johnathon Yoder	
Medical Specialties-	John Gaylord, Jr.	
Meridian Dyed Yarn Group (Valdese Mfg Co)	Rob Setliff	rsetliff@mdyg.com
Miami Thread Inc	Ronnie Daughtery	miamithread@conninc.com
Microban Products Company	Kevin Parrish	donna.nasko@microban.com
MikroPul		slavin@mikropul.com
Milliken & Company	Mike Tutterow	mike.tutterow@milliken.com, tod.dailey@milliken.com

Mills Manufacturing Corp	James Turner	jwturner@millsmanufacturing.com, info@millsmanufacturing.com
Modern Densifying, Inc.	Andy Ball	mbi@shelby.net
Mount Pleasant Hosiery Mills	Robert Hayes	vritzell@mtpleasanthoiserymills.com
Murdock Webbing Co Inc	Vann Cummings	vann.cummings@murdockwebbing.com
Nanofiber Technology Inc.	Richard Findlow	nanofiber@mindspring.com
National Air Filters, Inc.	Jim Hoffman	jim@filtersonline.com, stephen@filtersonline.com
National Spinning Co Inc	Jim Booterbaugh	jbooterbaugh@natspin.com
Natvar Company	George Coggins	sales@natvar.com
Neptco Inc.	Guy Marini	GMarini@neptco.com
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Nilit America Corp	Billy Lawson	billyl@nilit.com, mollyk@nilit.com
N.C. Spinning Mills/ Wyndmoor Industries Inc	Robert Lehrer	ecpelehrer@aol.com
North Safety Products LLC	Jim Young	jim.young@northsafety.com
North State Flexibles	Denny Wine	hr@nstatepkg.com, denny.wine@nstatepkg.com
Northwest Co/ Wilmington Products USA Inc	Michael Booser	
Norvell D W Tent Mfg Co	Stephen Puckett	
Noveon Inc. (Lubrizol)	Bob Bonner	bob.bonner@lubrizol.com
Nutex Concepts of North	Arnold Moore III	
Optimum Filtration Company	Ronald Holloman	ron@optimumfiltration.com, info@optimumfiltration.com
Paraclete MSA Armor & Equipment	Kim Henry	kim.henry@msanet.com
Parkdale Mills Inc	Dan Morrison	dmorrison@parkdalemills.com, dougwoolweaver@parkdalemills.com
Pep Filters	Mike Miller	mmiller@pepfilters.com
PGI Nonwovens	Sherry Sutton	suttonsh@pginw.com
Pharr Yarns Inc	Bill Carstarphen	bill.carstarphen@pharryarns.com
Pneumafil Corp.	Rick Hamby	tsinfo@pneumafil.com, rhamby@pneumafil.com
PPG Industries Fiber	Tim Mathis	mathis@pp.com

Glass Products, Inc.		
Precept Medical Products	Michael Boyd	
Precision Fabrics Group Inc	Joe Capobianco	joe.capobianco@precisionfabrics.com
Pulcra Chemicals LLC	Jeff Langley	
Quantum Group Inc	Jeff Bruner	jbruner@quantum5280.com, jtuu@msn.com
R & J Webbing Corp	Larry Rosenfield	rjweb@bellsouth.net
R L Stowe Mills Inc	Steve Messer	
RadiciSpandex Corp	Marty Moran	mmoran@radicispandex.com, khall@radicispandex.com
Rayco Safety, Inc.	Ray McBride	ray@raycosafety.com
Reichhold Chemicals Inc.	John Gaither	
Rohm and Haas Company	Kay Sanborn	ksanborn@rohmhass.com
RX Textiles Inc	Joseph Davant	JDavant@RXTextiles.com
Saab Barracuda LLC	Bill Easterling	send email directly through website
Sapona Manufacturing Co Inc	Pete McMichael	
Sarstedt Inc.	Carolyn Fulbright	sarstedt@bellsouth.net attn: Carolyn
Saunders Thread Co	Charles Saunders	saunders@saunders-thread.com
Schneider Mills Inc	Hank Byrd	hbyrd@schneidermills.com
Service Thread Manufacturing/ Sam M Butler	Leslie Bathie/Jay Todd	Leslie.Bathie@servicethread.com, Steve.Pullen@servicethread.com
Sherman Textile Co Inc	Peter Nicoletti	
Shuford Mills Inc	Jeff Jimison	jjimison@shurtape.com
Slosman Corp & Ness	Jo Curtis	
Snyder Paper Corp	Larry Kahill	spchickory@snyderpaper.com
Southern Glove Mfg Co	Brent Fidler	bfidler@southernglove.com
Spanset Inc	Ken Milligan	k.milligan@spanset-usa.com
Spectrum Dyed Yarns Inc	Doug Blanchard	doug.blanchard@sdy.com, doug@sdy.com
Spencer's Inc	Tony Williams	twilliams@spencers.com
Spuntech Industries	Gary Becker	gary-b@spuntech.com
Standard Tytape Co Inc	Bob Herrmann	tytape@bellsouth.net

STI Kings Plush Inc	John Kay	
Stockhausen Inc.	Ulrich Sieler	
Strandberg Engineering Laboratories Inc.	John Strandberg	sensors@strandberg.com
Sunbelt Textiles Inc	Mike Dixon Jr	mdixon@sunbelttextiles.com
Superior Fire Hose Corp	Tony Sposato	
Swift Galey-Swift Denim and Galey & Lord	Mary Deal	mdeal@swiftgaley.com
Taylor Togs/Apparel Technologies Inc	Grier Lackey	
TC2-Textile/Clothing Technology Corporation	Michael Fralix	mfralix@tc2.com
Techstyles Inc	Gail Presnell	
Tietex Interiors	Bill Dix	
Trion, Inc.	Robert Clemens	
Tuscarora Yarns Inc	Peter Hegarty	phegarty@tuscarorayarns.com
Twin City Knitting Co., Inc.	Francis Davis	fbdavis@twincityknitting.com
Ultra-Flex Manufacturing	Phil Dickerson	pjdickerson@hickorysprings.com
Unifi Inc	Roy Gibson	rgibson@unifi.com
Unifour Finishers Inc	Rick Setzer	all@unifourfinishers.com
US GreenFiber	Harold Pinkston	Harold.pinkston@greenfiber.com
Ventara Corporation	Scott Gehring	richard@ventaracorp.com
Vision Knit Technology Inc	Michael Guy	
Flexible Foam Products, Inc.	Laura Davis	
Wall Industries Inc	Stanley Swider	rope_info@wallrope.com
Wear-Flex Slings	Earl Johnson	ejohnson@americanwebbing.com
Webster Enterprises Inc.	Darrell Fox	dfox@websterenterprises.org
Wellman Inc.	Sam Cawa	sam.cawa@wellmaninc.com
Wmmt Manufacturing Co	William Warren	
Zellweger Uster Corporation	Alvin Ellison	alvin.ellison@uster.com

Cover Letter: B3

July 23, 2009

Dear NC Textile Company,

North Carolina State University's College of Textiles is conducting an on-going study that focuses on the innovation needs and competitiveness of the performance textile industry. Performance textiles are materials and products manufactured primarily for their technical and performance properties in addition to their aesthetic or decorative characteristics.

The study, which is funded by the North Carolina Department of Commerce, focuses on building a framework for global competitiveness. Components of the framework include trade, supply chain processes and position, unique products, market segments, etc. Innovation of new products and the attributes that contribute to the product's success are also important factors of competitiveness. The North Carolina Department of Commerce is specifically interested in ways to sustain competitiveness in the performance textile sector.

Your company has been recognized as a producer and/or marketer in North Carolina's performance textile industry. For that reason, we would greatly appreciate your participation in the study by completing the enclosed instruments. By participating, your company's data will be used to build an overall framework for benchmarking competitiveness. Additionally, your company will have access to the study's findings after its completion. Your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time. All information received will be considered confidential. Responses will be coded, de-identified, and all possible company information removed. Final reported data will not include any one company's individual responses. The reported data will be a combination of all the acquired data.

Included with this letter are three instruments that will help to establish methods of creating and sustaining competitiveness and innovation for performance textile companies. We ask that you complete the tools in the following order:

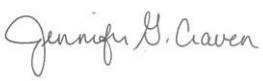
- The Innovation Framework lists many types of innovation throughout the product lifecycle, as well as a set of attributes that could come into play for different types of innovation. Completed charts will potentially reveal the most

important types of innovation, or types that companies ought to pay special attention to in order to achieve greater competitiveness.

- The Competitiveness Framework shows a basic "cause-and-effect" diagram, onto which items will be placed to show the most important factors contributing to global competitiveness.
- The Innovation Measures tool takes the Innovation Framework one step further by asking companies how they measure innovation attributes.

Please complete and return the three instruments by **August 21, 2009** via mail in the enclosed envelope. If there are any questions, please contact Jennifer at jegildea@ncsu.edu or (814) 720-0074. If at any time you have questions about your participation, do not hesitate to contact the researchers. If you feel you have not been treated according to the descriptions in this form, or your rights as a participant in research have been violated during the course of this project, you may contact Deb Paxton, Regulatory Compliance Administrator, Box 7514, NCSU Campus (919/515-4514). Thank you for your contributions to the project and your interest in sustaining a Performance Textile sector.

Best Regards,

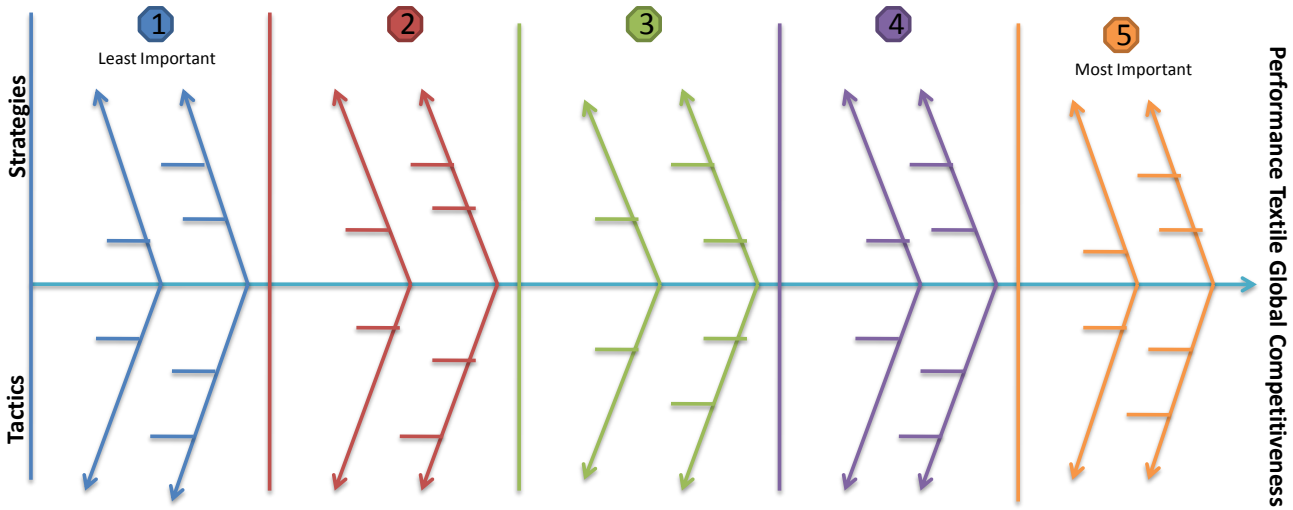


Jennifer G. Craven, Graduate Research Assistant
Nancy Cassill, Professor and Department Head, Textile and Apparel Technology and Management
Blanton Godfrey, Dean of the College of Textiles
Trevor Little, Professor, Textile and Apparel Technology and Management

Appendix C: Frameworks
Competitiveness Framework: C1

To Build the Performance Textile Competitiveness Framework

From the set of Performance Indicators below, write the corresponding letter (A –MM) on the chart to identify its importance and whether it is a strategy or a tactic related to competitiveness.



Strategy: a *plan* or *method* for obtaining global competitiveness.
Tactic: a *maneuver*, *procedure*, or *expedient* for promoting global competitiveness.

Performance Indicators

A. Marketing
B. Own Technology
C. Data
D. Manufacturing
E. Design
F. New Products
G. Product Costs
H. Interest Rates

I. Financing
J. Compliance
K. Economic Order Quantities
L. Quality
M. Supplier Capabilities
N. Supplier Certification
O. Supplier Proximity
P. Supplier Issues (other)

Q. Customer Specifications
R. Customer Lead Times
S. Customer Issues (other)
T. Chargebacks
U. Testing
V. Specifications
W. Raw Material Availability
X. Technology Availability

Y. Company Location
Z. Connection in Supply Chain
AA. Import/Export Capabilities
BB. Unique Products
CC. Promotion
DD. Standards
EE. Global Perspectives of business

FF. Web site
GG. Textile Association
HH. Trade Show
II. Company Growth
JJ. Sustainability
KK. Training and HR
LL. Other _____
MM. Other _____

Innovation Framework: C2

Below is a framework for Types of Innovation and the attributes used throughout the product lifecycle.
For each of the Types of Innovation listed, place an "X" in the box to identify if an attribute applies to that Type of Innovation. (See definitions)

	Types of Innovation														
	Product Leadership Zone				Customer Intimacy Zone				Operational Excellence Zone				Acquisition Zone	Other	
	Disruptive Innovation	Application Innovation	Product Innovation	Platform Innovation	Line-Extention Innovation	Enhancement Innovation	Marketing Innovation	Experiential Innovation	Value-Engineering Innovation	Integration Innovation	Process Innovation	Value-Migration Innovation			
Attributes															**TOTALS:**
Intellectual Property															
Cost - Meeting target cost															
Standards															
Certification															
Traceability - Component tracking															
End Use Demands															
Technology Availability															
Financial Investment															
Design of Materials															
Design for Aesthetics															
Design to Specification															
Lead Times - Response Time															
Raw Material Availability															
Sustainability															
Compliance															
Time to Market															
Need to Enter New Market															
Other															
Other															

Innovation Measures: C3

Of your top 5 attributes identified from the Innovation Framework, list the data your company collects or would collect to support each attribute.

Attribute	Data used to measure the attribute
Intellectual Property	
Cost - Meeting target cost	
Standards	
Certification	
Traceability - Component tracking	
End Use Demands	
Technology Availability	
Financial Investment	
Design of Materials	
Design for Aesthetics	
Design to Specification	
Lead Times - Response time	
Raw Material Availability	
Sustainability	
Compliance	
Time to Market	
Need to Enter New Market	
Other	
Other	
Other	

Additional Comments and/or Suggestions:

Appendix D: IRB Exemption

North Carolina State University is a land-grant university and a constituent institution of The University of North Carolina

Office of Research and Graduate Studies

NC STATE UNIVERSITY

Sponsored Programs and Regulatory Compliance
Campus Box 7514
2701 Sullivan Drive
Raleigh, NC 27695-7514

919.515.2444
919.515.7721 (fax)

From: Carol Mickelson, IRB Coordinator
North Carolina State University
Institutional Review Board

Date: August 20, 2009

Project Title: Building the Performance Textile Competitiveness Framework for New Product Innovation

IRB#: 1039-09-08

Dear Ms. Jennifer Craven:

The research proposal named above has received administrative review and has been approved as exempt from the policy as outlined in the Code of Federal Regulations (Exemption: 46.101. b.2). Provided that the only participation of the subjects is as described in the proposal narrative, this project is exempt from further review.

NOTE:

1. This committee complies with requirements found in Title 45 part 46 of The Code of Federal Regulations. For NCSU projects, the Assurance Number is: FWA00003429.
2. Any changes to the research must be submitted and approved by the IRB prior to implementation.
3. If any unanticipated problems occur, they must be reported to the IRB office within 5 business days.

Please provide your faculty advisor (Dr. Trevor Little) with a copy of this letter. Thank you.

Sincerely,

Carol Mickelson
NCSU IRB

Appendix E: TRIZ Flow Framework

(Bicheno, 2006) or http://www.triz-journal.com/archives/2006/12/09.gif