

ABSTRACT

NELSON, HOLLI GREER. Building the Performance Cluster in North Carolina: Providing Assistance to Enhance Global Market Competitiveness of the North Carolina Textile Industry. (Under the direction of Dr. Nancy Cassill).

The purpose of this research study was to conduct an analysis of the performance textile industry in North Carolina and provide the foundation for building a “performance cluster” in North Carolina. Another purpose of this research was to analyze factors that contribute to or hinder competitiveness in the textile and apparel industry in terms of performance textile applications. The performance textile sector provides competitive, value added market opportunities. In addition to performance textile markets providing competitive advantage, innovative and value added product and process opportunities are achieved through performance applications. Globally, technical textiles are considered to be the fastest growing sector of the textile market (Shisoo, 2004). Performance textiles are 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). Since performance textiles impact economic and social activity (Horrocks & Anand, 2000) performance textiles can provide North Carolina textile and apparel companies with production and market opportunities for differentiated products. This research sought to holistically analyze and profile the North Carolina performance textile complex.

The conceptual models used in this study provided a framework for applying innovation in products and processes. Innovation is a market driver in terms of performance textiles. The models examined were 1) Jacobs’ Lifecycle of Innovation (Jacobs, 2007), and 2) the Textile Added Value Curve (Cassill et al, 2006). Both models are used to examine

innovation and added value in terms of product categories, pre production, manufacturing, and post production processes. The Lifecycle of Innovation model is specific to product categories, not single products which are most often plotted on lifecycle diagrams. Product categories may experience decline at some point, but due to renewal (innovation) they can be revived (Jacobs, 2007). The Textile Added Value Curve provides a framework for processes related to providing differentiated products undeterred by cost pressures and competition. Both models provide a method for regaining competitive advantage through innovation and added value.

The methodology used in this study used a two phase approach to address the research objectives of this study. Each phase consisted of a focus group for data collection (qualitative). Phase I included an analysis of the global performance textile industry in addition to the performance textile industry specific to North Carolina. Phase I identified the performance textile industry in North Carolina through geographic clusters. Phase II provided an analysis of growth opportunities and competitiveness issues specific to the North Carolina performance textile complex. Phase II validated the geographic cluster structure of four opportunistic performance sectors; protective, medical, industrial and construction. Phase II focus groups contained the following sections: global competitiveness, growth potential, market trends, innovation, added value, advanced manufacturing, quality, standards, technical performance, and industry needs. Phase II focus groups were divided into narrowed, market segments in order to obtain detailed sector information.

Results indicated that there is a significant and growing presence of the performance textile industry in North Carolina. In addition, recommendations and strategies for continued business and economic development were provided specific to the needs of the performance

textile industry. The research validated Jacobs' (2007) Lifecycle of Innovation and the Textile Added Value Curve (2006) as methods for measuring innovation and value added processes. Additionally, the research confirmed the presence of the performance textile cluster as outlined by Cassill (2006) by providing geographical cluster representation of the industry and its growth opportunities. Results indicated that performance textile markets can provide methods for achieving competitive advantage through innovative and value added products and processes in North Carolina.

Building the Performance Cluster in North Carolina: Providing Assistance
to Enhance Global Market Competitiveness of the
North Carolina Textile Industry

by

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CHAPTER 1

INTRODUCTION

The textile industry has traditionally been one of the largest industries of the United States (US) economy. Escalating production prices and the threat of increased competition, especially from the Asia Pacific region, has meant that foreign producers have gained a greater share of the United States market (Datamonitor, 2004). Additionally, the global elimination of quotas at the end of 2004 has led to greater competition (Technopak, 2007). In today's competitive global textile and apparel marketplace, industries in developed countries are challenged to provide differentiated products that provide alternatives to low-margin undifferentiated, commodity products.

It has been suggested that companies focus on products that offer a competitive advantage over commodity products (Standard & Poor's, 2003). Researchers suggest the US textile industry should turn to highly value-added, niche segments in order to survive in the competitive global market (Oh & Suh, 2003). One way of doing this is to focus on specialized, or niche, products (Parrish, 2004).

A niche market opportunity specific to the textile and apparel industry lies in the application of performance textile products and services. The performance textile sector provides new avenues for US companies who have experienced little growth due to intensified competition in apparel and household textile markets. All indications are that the applications and markets for technical textiles in the United States and abroad will continue to evolve and grow (Kaufman, 2007).

Performance textiles are 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). Performance textiles provide long term potential for many domestic companies (Chang, Kilduff 2002). In many developed countries technical textiles now account for an average of 40% of both production and consumption according to Michael Janecke of Messe Frankfurt, the organizer of the Tectextile tradeshows (Shisoo, 2007).

The performance textile sector provides competitive, value added market opportunities. Globally, technical textiles are considered to be the fastest growing sector of the textile market (Shisoo, 2004). Michael Porter’s (1998) research on competitive advantage is well known in the literature and his theories in terms of cluster development, achieving competitive advantage, and strategy have been validated by fellow researchers. (Parrish, 2003; Allen, 2006; Berdine, 2007). In addition to performance textile markets providing competitive advantage, innovative and value added product opportunities are achieved through performance product applications. Dany Jacobs (2007) addresses varying degrees of innovations and value added opportunities.

The Textile Added Value Curve provides a framework for processes related to providing differentiated products undeterred by cost pressures and competition. The distribution of textile complex business continues to evolve to include pre-production, production, and post-production processes. Traditionally, the “textile industry” was defined by production activities (NAIC 313 – 315), but due to global, post quota dynamics,

companies must transform their business activities to include “textile complex” and added value activities (Cassill, Frederick, Godfrey, Little, 2007). The curve depicts today’s dynamics of the global textile business, illustrating the “value-added” operations in the pre-production and post-production stages, with lower “value-added” in manufacturing operations, thus serving as a framework for assessing opportunities in North Carolina to achieve such value-added processes.

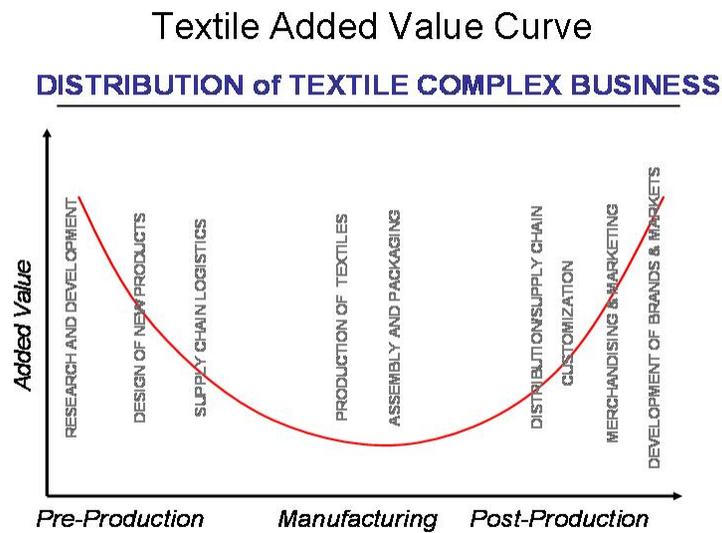


Figure 1. The textile added value curve.

Source: Cassill, N.; Godfrey, B., & Little, T. (2006). “The New World of Textiles”, white paper, NC State College of Textiles Strategic Planning Session, Raleigh, North Carolina.

Intense global restructuring of the textile and apparel industry has provided challenges and opportunities for North Carolina and its' textile infrastructure. Challenges include how to differentiate products that add value and market performance features to existing and new global customers. Throughout the North Carolina textile supply chain, opportunities exist to overcome these challenges and in turn yield a competitive advantage.

Previous research ("State of the Union", 2006; Kilduff & Chang, 2002; Rigby Associates, 2002) suggests that the performance textile sector does have significant growth opportunities in the production and marketing of value added products, thus addressing the dynamics facing North Carolina at present. Currently, the market for technical textiles in the USA is the largest worldwide (Shisoo, 2007). Since performance textiles impact economic and social activity (Horrocks & Anand, 2000) performance textiles can provide North Carolina textile and apparel companies with production and market opportunities for differentiated products.

To assist the North Carolina textile and apparel industry in global competitiveness initiatives, North Carolina State University College of Textiles' researchers and personnel from the North Carolina Department of Commerce have identified an opportunity to further develop the performance textile sector in North Carolina. North Carolina's traditional textile and apparel expertise and infrastructure consists of market and product knowledge, research and development (including new product development) facilities and knowledge, production capabilities, and distribution expertise. While no documented research exists profiling the North Carolina performance textile industry, it is speculated that the industry is diverse in markets served, including diverse end use markets.

This research project provides an examination of the global performance textile industry, with an examination of the current North Carolina performance textile industry – and the inclusion of the performance textile sub-sectors of this industry. Challenges and opportunities for North Carolina textile companies, the support needed to assist these companies and the steps to build a competitive performance textile cluster in the State are also discussed. The research project provides the foundation and guidance for establishing a performance textile cluster in North Carolina.

Purpose of Research

The purpose of this research study was to conduct an analysis of the performance textile industry in North Carolina and provide the foundation for building a “performance cluster” in North Carolina. Another purpose of this research was to analyze factors that contribute to or hinder competitiveness in the textile and apparel industry in terms of performance textile applications.

A two phase approach was used to address the research objectives of this study. Phase I included an analysis of the global performance textile industry in addition to the performance textile industry specific to North Carolina. Phase II provided an analysis of growth opportunities and competitiveness issues specific to the North Carolina performance textile complex. Figure 2 provides a framework for the research process.

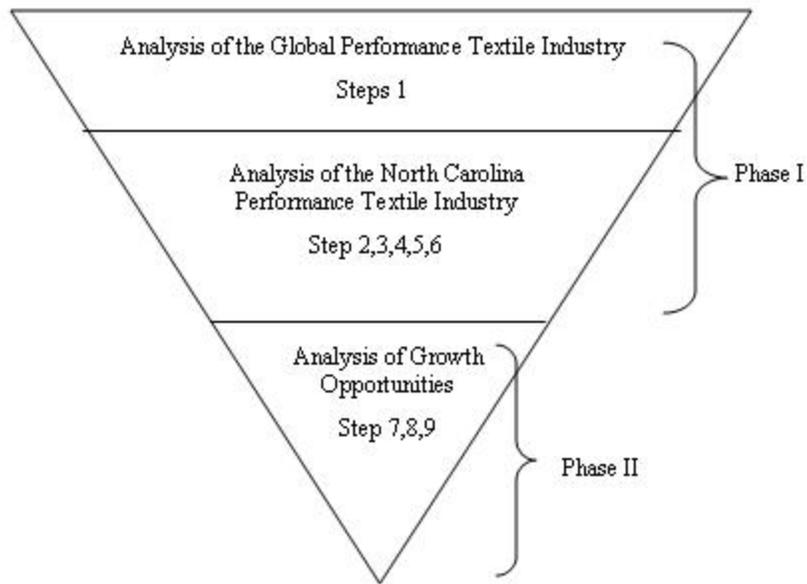


Figure 2 Research Design.
Source: Author (Nelson, 2007)

Research Objectives

Research objectives for Phase 1 include key themes associated with understanding the global performance textile industry and its' presence in North Carolina.

Phase I: Exploratory

RO1: To analyze the global performance textile industry including product and market dynamics, shifts in marketing strategies, and industry characteristics using secondary sources.

RO2: To analyze the North Carolina performance textile industry by providing a profile of the performance textile industry using secondary and primary sources in order to:

RO2A: Understand current industry dynamics;

RO2A1: Number of companies;

RO2A2: Number of counties;

RO2A3: Cluster configuration;

RO2A4: Estimated annual sales;

RO2A5: Employees;

RO2A6: Products produced;

RO2A7: Companies competing.

RO3: To identify North Carolina companies competing in the performance textile industry using appropriate sub-sector definitions.

RO4: To identify the cluster structure and dynamics of performance textile companies.

RO5: To conduct a focus group for validation of RO1-RO4. A focus group session will be used to determine:

RO5A1: Industry requirements

RO5A2: Cluster Formation

RO5A3: Trade and Expertise

RO5A4: Information needed for competitiveness

RO6: To identify and validate opportunistic sub-sectors for further analyses using quantitative and qualitative criteria.

Phase II: Concurrent Triangulation

Deductive Approach

Research objectives for Phase II include key themes associated with understanding sub-sectors with the most economic development and growth potential for North Carolina. Selected sub-sectors included: protection (military), medical, industrial, and geotextile (construction).

RO7: To conduct focus groups with each of the identified growth sub-sectors to determine:

RO7A: Factors that contribute to or hinder competitiveness in the textile and apparel industry in terms of:

RO7A1: Global competitiveness, growth potential, market trends

RO7A2: Innovation, added value, advanced manufacturing

RO7A3: Quality, standards and technical performance

RO7A4: Industry needs

RO8: To validate growth sub-sectors in terms of:

RO8A1: Number of companies;

RO8A2: Number of counties;

RO8A3: Cluster configuration;

RO8A4: Estimated annual sales;

RO8A5: Employees;

RO8A6: Products produced;

RO8A67: Companies competing.

RO9: To refine the variables for adding value and address the dynamics in terms of performance textiles related to the Textile Added Value Curve and Jacob's (2007) Lifecycle of Innovation.

Significance of the Study

This study provides an analysis of the performance textile industry in North Carolina. Additionally, growth opportunities for performance textile markets specific to North Carolina are identified. Results provide an overview of the performance textile industry, performance textile cluster locations, growth opportunities for each cluster, and recommendations for continued development in terms of the performance textile industry in the State.

Specific significance includes:

1. Economic Development

- a. The performance textile sector provides an economic opportunity for textile companies who can no longer compete with direct foreign competition.
- b. Information about this sector combined with educational opportunities and a cluster initiative will assist companies in regaining global competitiveness and allow North Carolina companies to have a competitive advantage in the performance textile industry

2. Workforce Development

- a. North Carolina will establish a performance textile infrastructure which will impact the textile industry as well as complementary industries.
- b. Companies will be attracted to the state's performance textile expertise.

- c. Companies currently competing in North Carolina will have more opportunities for development and expansion.
- d. Government, industry, academe, trade associations, technical colleges, and vocational training centers will work together for the cluster initiative to be successful.

3. Export Development

- a. North Carolina companies will have opportunities to expand offshore.
- b. North Carolina's textile expertise will increase export opportunities by providing technical products that are not easily duplicated.

Limitations of the Study

There are five limitations to the research study.

1) Definition of industry

The performance textile industry is not well defined and limited research exists about the industry. Various handbooks, academic journals, and industry leaders define the industry quite differently. No two published sources, industry bodies or organizations ever seem to adopt precisely the same approach when it comes to describing and categorizing specific products and applications of performance textiles (Horrocks & Anand, 2000). In addition, the statistical definitions that are used to measure the textile industry are based on traditional classification. The definitions within both the SIC and NAICS systems focus on broad activities or product categories. Many performance products are not specifically identified in official data but are typically classified according to fiber, yarn content, and process (Woon, 2002).

The literature defines this segment of the industry as “technical textiles”. Industry representatives, academia, and government in North Carolina have used the term of “performance textiles” when defining the segment. Performance textile has proven to be a growth market for the state, while historically known as “technical textiles”, North Carolina industry has confirmed “performance textiles” to be most inclusive. In the research, the term performance textiles will include the definition of technical textiles.

2) *Definition of end market*

A secondary limitation of the research project relates to defining end markets and quantifying their market share. Performance textile sub-sectors have many overlaps, often use the same raw material, and pass through similar levels of processing and manufacturing. Thus, it is difficult to strictly define products and determine sub-sector affiliation.

3) *North Carolina Textile Complex Database*

The third limitation of the research project relates to the use of the North Carolina Textile Complex Database. As discussed in the 2006 research project, the North Carolina Textile Complex Database has four limitations:

- a) Some companies that are involved in the textile business may be reporting diverse (non traditional textiles) NAICS, and have not been included in the database. Known under-represented companies include
 - a. Consumer product companies (e.g., Proctor & Gamble)
 - b. Service industries and auxiliary firms supporting the textile complex.
 - c. Performance apparel companies (due to limiting definition of performance

apparel)

- b) The database captures a point in time and may not represent daily business dynamics (growth, entering or exiting the textile industry).
 - c) With 91% of companies represented in the database being privately held, limited information was obtained by many of the private companies (due, in part, to fewer reporting requirements of private companies vs. public companies). While the researchers are familiar with many North Carolina companies, proprietary information is based on estimates provided in secondary literature. All markets may not be represented due to the private nature of information available.
 - d) Sales data are represented in the database is incomplete, due to the proprietary nature of private companies (Cassill et al, 2006).
4. A convenience sample of North Carolina companies was used for both Phase I and Phase II. Companies participating in this study were identified by the researcher and NC State College of Textiles personnel.
5. Phase II was limited to a manageable number of identified growth sub-sectors for further explanation. Other sub-sectors may provide different results.

Conceptual Definitions

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

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

Added Value (or value innovation)- Based on the ambition to dominate the market by offering a tremendous leap in value (Kim & Mauborne, 1998).

Competitive advantage- Is 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).

Environmental textiles- Textiles used in environmental protection (Horrocks & Anand, 2000).

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

Home furnishings textiles- Technical components of furniture, household textiles, and floorcovering (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 apparel textiles- Technical components of footwear and clothing (Horrocks & Anand, 2000).

Packaging textiles- Textiles used in packaging 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 “technical textiles” definition from Horrocks & Anand, 2000).

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

Sport textiles- Textiles used in sport and leisure (Horrocks & Anand, 2000).

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).

Transportation textiles- Textiles used in automobiles, shipping, railways, and aerospace (Horrocks & Anand, 2000).

CHAPTER II

LITERATURE REVIEW

Conceptual Framework

Two conceptual models were used for this research. The first relates to innovation and the second is specific to adding value throughout the textile complex. The first conceptual model for this research is Dany Jacob's (2007), *Diversity of Innovation from a Lifetime Perspective*, (2007) as shown in Figure 3. This model was developed to chart the various kinds of innovation, according to how near to an "original radical innovation" they take place (Jacobs, 2007). Jacobs adapted the model from Geoffrey Moore (2005). Jacob's adaptation remains true to the core of the model; there are numerous peaks in the model thus charting the lifecycle of a product category rather than a single product.

According to Jacobs and Moore, assessing innovation through a one peak lifecycle approach is not sufficient. This framework is specific to product categories, not single products which are most often plotted on lifecycle diagrams. Product categories may experience decline at some point, but due to renewal they can be revived (Jacobs, 2007).

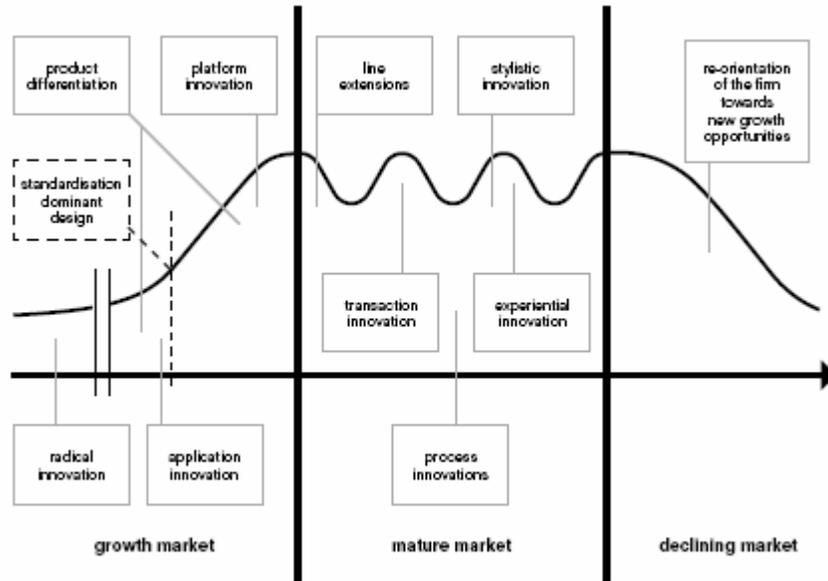


Figure 3 Conceptual Research Model-Lifecycle of Innovation

Source: Jacobs, D. (2007). *Adding Values: The Cultural Side of Innovation*. Rotterdam: Art EZ Press/Veenman Publishers.

The second conceptual model used is the Textile Added Value Curve created by NCSU researchers (Cassil et al, 2006). The Textile Added Value Curve provides a framework for processes related to providing differentiated products undeterred by cost pressures and competition. The distribution of textile complex business continues to evolve to include pre-production, production, and post-production processes. Traditionally, the “textile industry” was defined by production activities (NAIC 313 – 315), but due to global, post quota dynamics, companies must transform their business activities to include “textile complex” and added value activities (Cassill et al., 2007). The curve depicts today’s dynamics of the global textile business, illustrating the “value-added” operations in the pre-production and post-production stages, with lower “value-added” in manufacturing

operations, thus serving as a framework for assessing opportunities in North Carolina to achieve such value-added processes.

There is an opportunity to “lift” the curve (middle part of with manufacturing) with strategic identification of products to meet market needs and with sustaining manufacturing process (Cassill et al, 2006). Identification of strategic methods for “lifting” the curve will serve as the basis for using the Textile Added Value curve as a conceptual model for the research.

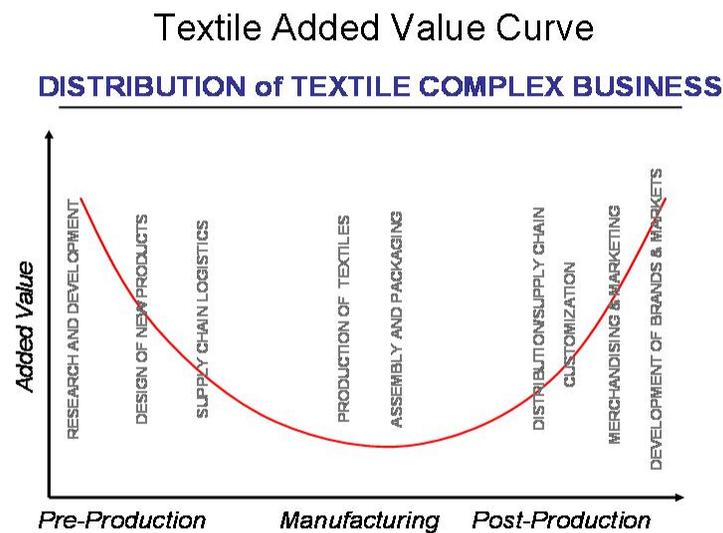


Figure 4 Conceptual Model-Textile added value curve.

Source: Cassill, N.; Godfrey, B., & Little, T. (2006). “The New World of Textiles”, white paper, NC State College of Textiles Strategic Planning Session, Raleigh, North Carolina.

Lifecycle of Innovation

In terms of Jacob's conceptual framework, the model begins with a new concept, paradigm, technology, or business model (Jacob's 2007). This new development is plotted at the start of the model (left position). Jacobs describes this new development as a "radical innovation". Radical innovation is a product, process, or service with either unprecedented performance features or familiar features that offer potential for significant improvements or cost (Jacobs, 2007). Often, radical innovations create such new products, processes, or services, that they create new markets or industries. The advent of rayon in the 1920's is an example of a textile related radical innovation (Plunkett, 2007).

Radical innovations do not occur regularly, but when they occur, they lead to a wave of all types and degrees of innovations. Product innovations are an integral component of radical innovations. Product innovations are specific to new material products, new information products, and new services. In the growth market phase, product innovations are most important because the product's physical attributes and capabilities most affect financial performance (Hunger & Wheelen, 2006).

The parallel lines after radical innovations on Figure 3 (conceptual model) emphasize that radical innovations are not always successful. A vertical line is drawn to represent the need to move from an early, innovative consumer group to that of a broader, more pragmatic group. This is an important step in the innovative process, because those products or services that do not meet the needs of a broader consumer group may fail.

Once a radical innovation has been accepted, useful applications may be further differentiated in the direction of other niche markets and in this way evolve into a more generic product (Jacobs 2007). Applications in diverse, niche markets have been established and product differentiation can occur. This movement is plotted in terms of product differentiation innovations and strategies.

Upon differentiating to meet the needs of generic consumer groups, a product category becomes standardized. It is through such standardization that the transition to a mass market becomes possible (Jacobs, 2007). In terms of technical innovations, the standardization process is critical in order to associate a product category with undisputed technical specifications.

Movement from a standardized design to broadened consumer awareness categorizes the end of a radical innovation. Rapidly growing industries (product categories) with relatively high profit margins always attract newcomers, and as a consequence in the next phase competition increases, productivity is enhanced and profit margins get thinner (Jacobs, 2007).

Once the radical innovation phase is complete, product differentiation occurs again. The product category is able to differentiate in order to more efficiently meet the needs of the mass market. Furthermore, platform innovations take place thus allowing production efficiencies to grow. Upon completion of platform innovations, the growth market phase has come to an end.

Product categories now shift to mature market placement on the Diversity of Innovation from a Lifetime Perspective model. During this stage, competition increases and

firms battle for the attention of consumers. The mature market phase consists mostly of process innovations. Process innovations are changes in production processes of products which in principle should lead to more efficient production, not only within factories and service organizations, but also between them by, organizing efficient forms of outsourcing, co-design, co-manufacturing, and logistics (Jacobs, 2007). Examples of process innovations are improved manufacturing facilities, increasing product quality, and faster distribution (Wheelen & Hunger, 2006). Process innovations are important to economic returns.

During the mature market phase, in terms of product, there are possible line extension, stylistic innovations, and experiential innovations. These innovations are specific to small product variations in terms of design, targeting different consumer markets, and experiences associated with the product. Tweaking the product in such a way is important for achieving transaction innovations which are also a component of the mature market phase. Transaction innovation refers to new ways of both bringing products to the attention of consumers' and selling them (Jacobs, 2007). Customers are the key focal point of transaction innovations.

Most importantly, Jacobs stresses the relation between the three basic types of innovation which occur throughout the Lifecycle of Innovation model. He describes this relationship as: product innovation concentrating on the product, process innovation focused on its production processes, and transaction innovation concerned with its customers (Jacobs, 2007).

The mature market phase of the innovation lifecycle can continue forever for some product categories. Apparel is one such product category that will remain in the mature

market forever because of its functional need. Likewise, some product categories will ultimately come to their end in the mature market phase. Typewriters and fax machines are examples of this type of decline.

If a product category ultimately reaches the decline market phase of the model, the firm must then reorient towards new growth opportunities. Essentially, a radical innovation must be developed thus the lifecycle of innovation can begin again.

The conceptual models for this study provide a framework for addressing product categories (textile and apparel) through a life-cycle and added-value approach. With a life-cycle approach, recommendations for achieving competitive advantage for mature and declining markets (domestic manufacturing of textiles and apparel) are provided. Jacobs' model was selected because 1) the theory is specific to innovative processes, 2) adding value to goods and services, and 3) niche markets. For assessing value added activities in the textile complex, Cassill's model (2006) was chosen. This model was chosen because it addresses value added activities in the preproduction, postproduction, and manufacturing phases of the product development process (Cassill et al, 2006).

Innovation

Due to increased competition and accelerated product development cycles, innovation and the management of technology are becoming critical to success (Wheelen & Hunger, 2006). Firms create successful competitive advantages by perceiving or discovering new and better ways to compete in an industry and bringing them to market which is ultimately an act of innovation (Berdine, 2007). A successful innovation is one that returns the original investment in development plus some additional returns (Burgelman et al, 2004).

Innovation and new product development is a positive factor in assessing performance. The most typical causes of innovations that shift competitive advantage during a product category's lifecycle are:

1. New Technologies
2. New or shifting buyer needs
3. The emergence of a new industry segment
4. Shifting input costs or availability
5. Changes in government regulation (Porter, 1990)

Jacobs defines innovation as *something new, which is presented in such a way that the value will be determined by the selectors* (Jacobs, 2007). Additionally, Jacobs describes innovation as a process through which new concepts and meanings are created and new categories are developed (Jacobs, 2007). Innovations can lead to value-added products. Most simplistically, *an innovation is something new with an added value* (Jacobs, 2007).

In terms of the drivers of innovation and product development, a firm should look to its stakeholders, especially customers, suppliers, and distributors for sources of product and service improvements (Wheelen & Hunger, 2006). Ultimately, stakeholders have the most to gain from innovation.

Innovations are the outcome of the innovative process, which can be defined as the combined activities leading to new, marketable products and services and/or new production and delivery systems (Burgelman et al, 2004). Lead users are important in the innovation process, specifically in developing radical innovations. Research by Won Hippel indicates that customers (throughout the supply chain) are a key source of innovation in many

industries (Wheelen & Hunger, 2007). Another critical factor in the innovation process understands a company's internal environment. In order to innovate effectively, a company must ask the following questions:

1. Has the company developed the resources needed to try new ideas?
2. Do the managers allow experimentation with new products or services?
3. Does the corporation encourage risk-taking and tolerate mistakes?
4. Are people more concerned with new ideas or with defending their turf?
5. Is it easy to form autonomous project teams (Wheelen & Hunger, 2007)?

The origin of innovations remains in question. Innovation is not only specific to applying new technologies, but in Porter's and Jacob's case is relevant to new ways of doing business. Companies can innovate through new product development, new production processes, innovative marketing techniques, or implementing strategic human resource development. Other literature states that innovation depends on technological as well as other critical capabilities in areas such as manufacturing, marketing and distribution, and human resource management (Burgelman et al, 2004). Furthermore, inventions and innovations may emerge anywhere in the processes of dealing with customer problems or carrying out scientific research (Jacobs, 2007).

It is imperative to understand the types of innovation. Porter most simplistically describes two different types of innovations. Innovators can be industry outsiders who lack the myopic mindset of those in an industry. Alternatively, innovations can come from company leaders with a nontraditional background who are willing and able to think beyond industry norms.

Jacobs further categorizes innovation in two categories; technical and non technical. Examples of technical innovations include the development of new jet airplanes, a new steel production process, or a new seed variety (Jacobs, 2007). Non technical innovations include new forms of organization, new fashions in clothing, new art styles, and new procedures. Jacob's suggests that generally technical innovations lead to non technical innovations in complementary or supporting industries.

Wheelen and Hunger (2006) describe four basic categories of innovation using a quadrant methodology.

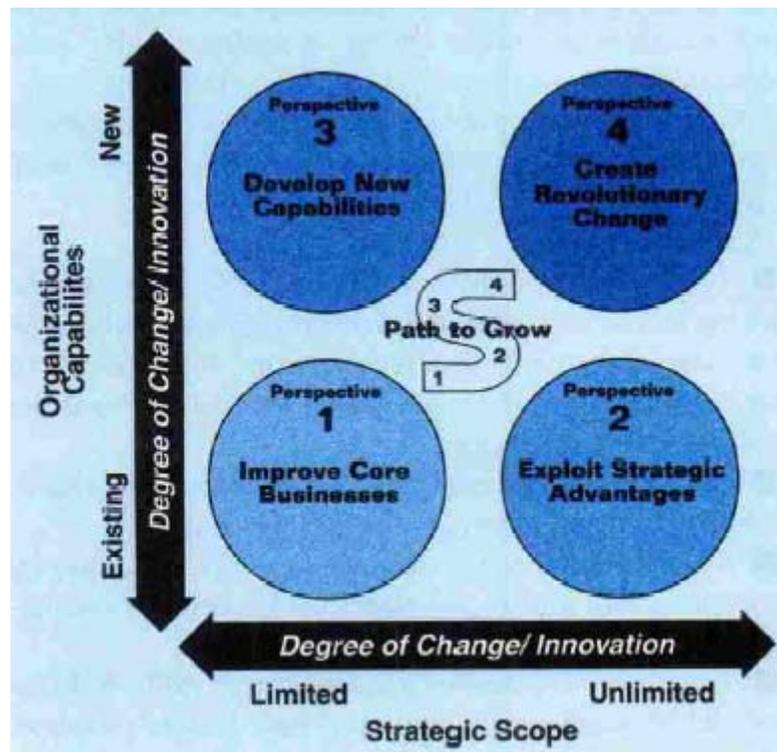


Figure 5 Categories of Innovation

Source: Hickman, C. & Raia, C. (2002). Incubating Innovation. *Journal of Business Strategy*, 4, 1-5.

Quadrant 1 focuses on improving core businesses. This type of innovation includes line extensions and improving existing products and markets. According to Jacobs improving core businesses can be accomplished through incremental innovations. Incremental innovations entails step by step improvements or style changes in existing products or services (Lipovetsky 1994, Jacobs 2007). Incremental innovations deter the consumer from getting bored. A firm that does not regularly create new models loses its market penetration and weakens its image of quality in a society where consumers spontaneously hold that the new is by nature superior to the old (Lipovetsky, 1994).

Quadrant 2 is important to exploiting strategic advantages. This strategy focuses on taking existing brands and product lines to new customers and markets without requiring a major change in current capabilities (Wheelen & Hunger, 2006). Product differentiation and the acceptance of a product by the mass market is a characteristic of Quadrant 2.

Quadrant 3 is used for developing new capabilities. A vertical growth strategy is used by Quadrant 3. The strategy focuses on improving organizational capabilities. In terms of Jacob's theory developing new capabilities can be accomplished through process innovations. Process innovations are changes in production processes of products which in principle should lead to more efficient production, not only within factories and service organizations, but also between them by, organizing efficient forms of outsourcing, co-design, co-manufacturing, and logistics (Jacobs, 2007).

According to Wheelen and Hunger, Quadrant 4 focuses on creating revolutionary change. Radical innovations (Jacobs, 2007) exist in the Quadrant. Fundamental changes and innovations exist in Quadrant 4.

Innovations can either be successful or unsuccessful. A study of 111 successful and 86 unsuccessful product innovations found that the successful innovations had the following features:

- They were moderately new to the market.
- They were based on tried and tested technology.
- They saved money; met customer's needs, and supported existing practices.

In terms of unsuccessful innovations, they had the following characteristics:

- They were based on cutting edge technology.
- They followed a "me too" approach.
- They were created with no clearly defined solution in mind (Wheelen & Hunger, 2006).

Adding Value through Innovation

Jacobs argues that in order to have economic 'value creation' (economic development) a process of innovation must be followed. Value innovation is a method for making competitors irrelevant (Kim & Maubornge, 1998). Logically, value innovation consists of providing a product or service in an unconventional manner at a lowered cost. Value innovation is based on the ambition to dominate the market by offering a tremendous leap in value (Kim & Mauborne, 1998).

Value is a preference not only inherent to consumers, but is also imperative through the supply chain. Organizations supplying products and services also need to see an added value in their activity (Jacobs, 2007). Value must be perceived by all participants in the supply chain in order to make service activities rewarding and profitable.

Suppliers and customers make different choices between competing value propositions, leaving room for a multitude of strategies (Jacobs, 2007). Determining what customers really value is essential for any firm's success; yet is not always easy. Firms must be proactive in researching what their customers value (Jacobs, 2007). Value innovation can be obtained by focusing on commonalities among consumer groups. Value innovations build on the powerful similarities in the features that customers value (Kim & Mauborgne, 1998).

Furthermore, value innovation strategy believes that most people will put aside their differences if they are offered a considerable increase in value. From this analysis, firms can improve performance. Understanding customer value perception is important; yet a firm must also use innovation to surprise customers with unexpected value propositions.

When assessing value innovation, it is important to ask the following four questions:

1. Which of the factors that our industry takes for granted should be eliminated?
2. Which factors should be reduced well below the industry's standard?
3. Which factors should be raised well above the industry's standard?
4. Which factors should be created that the industry has never offered (Kim & Mauborgne, 1998).

For successful unexpected value propositions, relative advantage and compatibility must be achieved. Everett Rogers (Diffusion of Innovation, 2003) discusses the relative advantage of innovation and compatibility. Relative advantage, or the degree to which an innovation is perceived as being better than the idea it supersedes (Rogers, 2003) most resembles the technical aspects of innovation (Jacobs, 2007).

Rogers defines compatibility as the second determining feature of innovation. Compatibility is seen as existing cultural ideas and values, as well as recognized needs, but of course may have a technical component as well: compatibility with existing technical standards (Rogers, 2003). The failure of many innovations is specific to the idea of incompatibility. Many radical innovations fail by being incompatible with existing demand or values, and also by failing to comply with existing technical and non technical systems of testing, implementation, production, commerce, or distribution (Jacobs, 2007).

Shifting from adding value to suppliers, adding value at the customer level is generally contingent on achieving three value dimensions; these are functionality, usability, and aesthetics.

- Functionality-design may improve the way in which a product implements or performs its intended functions, that is, its functionality. This is the most technical aspect of design.
- Usability-the measure of a product's potential to accomplish the goals of the user in an efficient, healthy, easy, and pleasant way. Usability deals with the paradox of simplicity: adding more features may increase the usability of a product related to some aspects but decreases its overall usability.
- Aesthetics-the visual beauty and appeal of a design. Visual beauty increases the acceptance of the product by the targeted customer group (Jacobs, 2007).

The connection between consumer preferences and characteristics of innovation are values (Jacobs, 2007). This connection, is the basis of the most simplistic definition of innovation; something new with an added value.

Innovation, Added Value, and Performance Textiles

In order for the textile and apparel industry to remain competitive, it is necessary to focus on the following: innovation, quality/design, high value added products, and flexibility/speed (Shisoo, 2006). Thus, US textile companies are turning to high-end, technically sophisticated areas of application (Shishoo, 2004). Specifically, performance textiles present a number of opportunities for companies in the textile industry. Performance textile sectors are new avenues for US companies who have experienced little growth due to intensified competition in apparel and household textile markets.

Innovation and value added products are the foundation for the performance textile industry. Performance textiles make use of new technology to develop novel products with added value (Shishoo, 2003). Furthermore, staying ahead of the technology curve is critical to succeeding in performance textile markets. It is a dynamic market that is constantly changing and innovating. Innovations in technical textiles occur daily (Kaufman, 2007). A driver of performance textiles is technical innovation that results in the wider application of textile materials across a broad range of end-uses (Chang, Kilduff, 2002).

Opportunities exist for domestic companies competing in the performance textile sector through innovation and value added products. “The current perception is that U.S. and European technical textiles manufacturers are the leaders in innovation, performance, quality, and technical merit of these engineered products, making them less susceptible to possible litigation” (Kaufman, 2007).

In order to be successful in technical textile markets, companies must stay ahead of the technology curve through innovative products and processes. Continuous investments in

technology and equipment are essential for achieving competitive advantage through technical applications. Alternatively, not all success in performance textiles rely on product innovations. Innovating processes for manufacturing are integral as well. Equipment can be rebuilt or modified to meet new standards for innovation, quality, and production (Kaufman, 2007).

Specifically, product innovation and performance attributes remain primary drivers for woven fabrics in performance textile markets; often at the expense of non-textile products the performance textiles are replacing (Kaufman, 2007). Additionally, innovations for the performance market are specific to advances in fiber, yarn, fabric, and manufacturing technologies. Following Jacob's (2007) definitions, innovations in the performance textile sector consist of technical, non-technical, radical, and non-radical innovations.

Also, success in the performance textile industry is linked with the price: performance ratio. In order to justify the added value of performance textiles, manufacturers have to innovate constantly, not just in materials and technologies, but also in marketing (Shisoo, 2004). Value creation specific to performance textiles is reliant on successful and effective marketing strategies that justify the value/added premium of performance textiles.

Customers play an integral role in the growing demand for performance textiles. Performance textile products allow customers to differentiate themselves. Traditional customer/supplier relationships are evolving into a working partnership (Kaufman, 2007). US companies investing in product development are fostering close partnerships with customers and providing new growth markets and isolation from international competition. Partnerships are needed to identify customers' needs and provide innovations to meet these needs. Strong

customer relationships in the performance market are imperative for meeting market and consumer needs.

The link between innovation and performance textiles is obvious. Without innovations and value added processes, performance textiles would not exist. Jacobs (2007) outlines 10 Rules for Innovation in his literature. Table 1 links each rule with performance textile characteristics.

Table 1 *Jacob's 10 Rules of Innovation and Performance Textiles Relationship*

Number	Jacob's Ten Rules of Innovation	Relationship to Performance Textiles	Source
1	Distinguish between technical and non technical aspects of innovation.	Innovations in performance textiles are a balance; it is the balance to be adopted between a technology-led and a market-led approach and its impact on policy for developing new products and services.	Technical Textiles International, 2004
2	Do not rely solely on technical innovations.	Understanding the consumer's needs are paramount. For success in performance textiles, all the elements of the manufacturing and marketing supply chains are re-engineered.	Technical Textiles International, 2004
3	The technical aspects of innovation are most important in the early stages of the life cycle of a product category.	Make use of technology to develop novel products with added value- exploiting skills, equipment, investment capital and advanced materials that are not readily available to emerging rivals. Performance textiles are the guiding light for business in the developed world.	Technical Textiles International, 2003
3	The more a product category is standardized, the more important the cultural value side of the product within the category becomes.	The lack of innovation over a prolonged period led to textiles becoming commodities with price becoming the primary differentiator. Value-added products are the solution. Textiles and clothing sectors have been transformed from low to high technology industries.	Technical Textiles International, 2007
4	The successful selection of innovation is an element of firm survival.	Those developing performance products need not fear the imminent encroachment of further competition from low-wage countries.	Technical Textiles International, 2003
5	Fitness of innovations in economic environments can be defined as value to consumers.	There is tremendous growth in technical fibers for sportswear and activewear and further profitable growth potential in non-apparel markets such as the automobile industry, medicine, telecommunications, and personal and property protection.	Technical Textile International, 2006
6	Creating economic value through innovation entails at least a marginal shift of consumer preferences.	In order to justify the added value of performance textiles, manufactures have to innovate constantly in both technologies and marketing. Performance textiles are oriented to the pull of the market.	Technical Textiles International, 2004
7	Internal selection of innovation occurs first.	Which performance markets should be chosen for entrance? An organization must begin by analysing its own existing business and to understand its strengths and weaknesses.	Technical Textiles International, 2003
7	External (market) selection of innovation occurs next.	Consumers in the industrialized world are demanding performance products. The customer is seeking products with specific performance and functional data.	Technical Textiles International, 2003
8	Innovation does not occur in isolation but is an element in a co-evolutionary system.	Partnerships along the supply chain are critical. Technical products require extensive research and development, but textiles is not traditionally a research oriented industry. Therefore, networking among industries is important.	Technical Textiles International, 2007
9	It is useful to observe the interaction between different selection systems of industries in order to understand strategic linkages.	Understand important emerging technologies; plasma technology, polymer science, chemical technology, environmental technology, and nano technology. Performance textiles customers are mostly non-textile (automotive or medical industries), therefore networking among industries is important.	Technical Textiles International, 2006
10	Innovation is a co-evolving interplay between the leading and following.	Keep innovation, never stagnate.	Technical Textiles International, 2003

Source: Adapted by H. Nelson (2007) from Jacobs, D. (2007). *Adding Values: The Cultural Side of Innovation*. Rotterdam: Art EZ Press/Veenman Publishers and Technical Textiles International *How to transform your business to technical textile series, 2002-20*

Performance Textiles

Performance textile research has more narrowly focused on the term “technical textiles”. For the purpose of this research, performance textiles are synonymous with technical textiles. Various research has been completed on the performance textile industry. Key researchers include: Chang and Kilduff (2002), Chi, Kilduff, and Dyer (2005), Horrocks and Anand, 2000, Rigby 2002, and Shisoo 2007.

Performance (technical, industrial, specialty, engineered) textiles present a number of opportunities for companies in the textile industry. Technical textiles are predominately characterized as having specific performance-based attributes and typically must meet established performance specification criteria (Kaufmann, 2007). Specifically, technical textiles are materials and products intended for end-uses other than non-protective clothing, household furnishing, and floor covering, where the fabric or fibrous component is selected principally but not exclusively for its performance and properties as opposed to its aesthetic or decorative characteristic. (Textile terms and Definitions). Technical textiles all have one common characteristic: the use of technology often engineered in fiber, yarn, and fabric form to provide specific technical performance characteristics to meet the final customer/market requirements, either as a final product in themselves or as a component in another product (Chang, Kilduff, 2002).

Technical textiles encompass a broad range of products and markets. In order to create some commonality in marketing communications, many companies are adopting the term technical textiles and the applications characterized by Techtexil (Kaufman, 2007). The research project uses an adaptation of these definitions.

- Agrotech-Agriculture, forestry, horticulture, landscape gardening
- Buildtech- Membrane construction, lightweight, and solid structures, earthworks and hydraulic engineering, and road construction
- Clothtech- Shoe and clothing manufacturing
- Geotech-Civil engineering, road, dam, and waste site construction
- Hometech- Furniture and upholstery manufacture, carpet and floor covering
- Indutech- Mechanical engineering, chemical, and electrical industries
- Medtech-Manufacturing, processing, and application of medical and hygiene products
- Oeketech- Environmental protection, recycling, and disposal
- Packtech- Packaging, coverings, and transport
- Protech- Personnel and property protection
- Sporttech-Sporting goods industry, leisure industry, and manufacture of outdoor equipment

Performance textiles are also segmented into seven product groups according to Tectextil. These include:

- Technology, machinery and accessories
 - Production processes, processing technology, machinery and equipment, control processes, cleaning and regeneration technology, waste disposal and recycling technology, technical accessories, and quality assurance.
- Fibers and yarns

- Woven fabrics, scrim, braids, and knitted fabrics
 - Tapes, string, cords, belts, ropes, and nets
- Nonwovens
- Coated textiles
 - Laminated textiles, tent/canvas material, packaging materials, sacking, tarpaulin fabrics, awning materials, coverings, and accessories.
- Composites
 - Reinforcing textiles, composite textiles, prepegs, structural components and moldings, fiber reinforced materials, membrane systems, films and sheeting, textile reinforced plastic and concrete components, piping and containers, and textile sheet products for laminating onto solids such as metal, plastic, and glass.
- Bondtec
 - Finishing technologies, sealing, molding materials, laminating and coating materials, application processing, material pre-treatment, adhesive mixing and application equipment, robot technologies, surface treatment technologies, plasma treatment and flocking (CRIFS, 2007).

Performance textiles have a much wider scope of economic activity than that of traditional textiles. Supporting industries are critical to the performance industry and its growth opportunities. The industry's suppliers include raw material producers, machinery and equipment manufacturers, information and management technology providers, research and development services, testing and certification bodies, consultants, education and

training organizations (Horrocks & Anand, 2000). Downstream customers include architects, engineers, and designers. Intermediary customers and suppliers include environmental, health, safety, business, free trade regulators, patent and intellectual property agents and lawyers, investors, bankers, regional investment, agencies, and providers of development aid.

Technical textiles provide long-term potential for many US textile companies. In 2000, estimates suggest it accounted for some 30% of end-use fiber consumption in the region and was worth 17 billion dollars (Chang & Kilduff, 2002). Technical textile demand is closely linked with economic activity. Another driver of technical textiles is technical innovation that results in the wider application of textile materials across a broad range of end-uses.

Due to the broad range of technical textile products and market applications, it is difficult to identify growth and product trends for the sector as a whole. However, all available indications are that the demand for technical textiles in most markets remains strong (Kaufman, 2007). Customer expectations and demand for technical textiles are expected to grow as product applications become better publicized, marketed, and understood.

As the performance textile market matures, global competition is becoming a factor. Asian polyester products have entered the performance textile market and export their oversupply of polyester throughout the world to be used in performance applications. Furthermore, India is looking to capture opportunities in nonwovens, composites, and product development. Machinery manufacturers are forced to manufacture offshore and have begun to license their technologies to partners in Asia and Eastern Europe. This threatens the

integrity of many of the core competencies of the performance textile industry, thus allowing greater opportunities for international competition.

The maturing performance market is experiencing other obstacles as well. Performance features such as strength, fire retardancy, and temperature resistance are now becoming requirements and are relatively easy to achieve by companies throughout the world. Furthermore, consumers are demanding these products. The market has switched from a push market to a pull market. The major driver of innovation in the growth of technical textiles consumption was technology push; today this is replaced by market pull (Rigby Associates, 2002).

The focus is now switching to the achievement of secondary product and performance characteristics such as low cost, lightness, recyclability, long life, and ease of replacement (Rigby Associates, 2002). Another factor driving the market is the low rate of innovative fibers introduced in the market. Companies are now looking to develop innovative fabrics, and find more end uses for products with existing technologies.

The technical textile and industrial textile sector are new avenues for US companies who have experienced little growth due to intensified competition in apparel and household textile markets. The technical textile industry is somewhat difficult to enter; it has high barriers to entry, lack of information, high costs of product development, and the difficulty of breaking into segments where strong relationships bind customers to established suppliers. (Chang & Kilduff 2002) Many companies are using realignment methods such as mergers, acquisitions, and divestitures as ways around these issues.

In addition to the added value of technical textiles resulting in higher profit margins for domestic companies, many companies choose to source technical textiles domestically. Consumers of technical textiles, especially in the more highly engineered applications appear to have a preference for local sourcing of technical textiles, instead of importing them (Kaufman, 2007). Sourcing domestically provides companies with a level of confidence in terms of quality, standard expectations, and technical performance. The current perception is that US and European technical textiles manufacturers are the leaders in innovation, performance, quality, and technical merit of these engineered products, making them less susceptible to possible litigation (Kaufman, 2007). Technical textiles can become commodities, most often this is the case in lesser grade technical textiles.

Technical markets can deter competition from developing countries by focusing on tight specification standards and highly technical products. US companies investing in product development are fostering close partnerships with customers and providing new growth markets and isolation from international competition. Technical textiles offer many export opportunities since many developing countries need technical products, but lack the infrastructure to manufacture them. All indications are that the applications and markets for technical textiles in the United States and abroad will continue to evolve and grow (Kaufman, 2007).

Related Literature

Several literature reviews were selected to provide the foundation for the research project. The first literature review provides the landscape of the global textile and apparel

industry in the post quota era. The second literature review assesses current competitiveness in the North Carolina textile industry. Technical textiles are identified as a growth opportunity in this research paper. The last literature review provides an analysis of current growth opportunities in performance textile markets.

Textile and Apparel Environment Post Quota: Today's Global Textile and Apparel Landscape

Manufacturers and buyers of textile and apparel have been forced to adapt to a plethora of changes in the years following quota elimination (Technopak, 2004). Additionally, the increase in raw materials costs, change in consumer demands, pressure from retailers, and need for speed have not only intensified the competitive playing field, but also provided opportunities for companies to find their niche.

Globally, the World Trade Organization reports that international trade in apparel totaled \$276 billion during 2005 (latest available data), or about 2.7% of all world merchandise trade (Plunkett, 2007). In terms of textiles, reports indicate trade totaled \$203 billion in 2005, or about 2.0% of world merchandise trade.

As years pass since complete quota elimination, companies are provided with a better picture of the new trading environment. A number of changes were expected for the textile and apparel industry post quota, yet the changes have been slow. Reasons for the slowed pace include proactive measures against Chinese imports in terms of safeguards and anti dumping duties. Over the next few years, it is expected that the pace of reforms will be must faster (Technopak, 2007).

Quotas continue to restrict Chinese imports to the United States and the EU in terms of certain textile and apparel products, yet these measures will be eliminated by the end of 2008. Safeguard quotas for Chinese imports to the US and EU cap imports deemed disruptive (Plunkett, 2007). These include sweaters, trousers, and brassieres. In the US, Chinese textile import growth was capped at 10% and 15% in 2006, between 12.5% and 16% in 2007 and between 15% and 17% in 2008 (Plunkett, 2007).

Sourcing strategies are also expected to quickly change. Prior to 2005, sourcing strategies were influence by the availability of quotas (Technopak, 2007). Post quota, companies are able to choose sourcing strategies based on competitive advantage, speed, relationships, and flexibility.

In terms of textile and apparel trade, estimates predict world textile and apparel trade will double in the ten years to 2015 (Technopak, 2007). From 2005 to 2015 trade will grow from \$480 billion to \$805 billion (Technopak, 2007). Trade will be dominated by the increase in demand of home textiles. Additionally, the rapid development of the Chinese and Indian markets will provide greater opportunities for the exportation of products to fulfill consumer needs. One consequence will be the stabilization of export growth from these countries by 2012 as an increasing proportion of their production is diverted to their respective domestic markets (Technopak, 2007). Innovations in textile and apparel products will be dominated by developed countries; US, UK, Germany, and Japan.

Most importantly post quota changes in world markets for textiles and apparel include:

- Consolidations and collaborations through acquisitions, mergers, and joint ventures

- Relocation of operations
- Redefinitions of conventional roles
- Local sourcing of textile products
- Regional textile and apparel production and exporting hubs will emerge
- Consideration of types of suppliers, relationships with suppliers, numbers of suppliers, and outsourcing some or all operations
- The emergence of heavyweight multi-billion dollar conglomerates
- The emergence of China and India as important consumer markets
- Renewed importance of small to medium sized firms competing with complex fashion products, niche products, or replenishment speed
- The growth and importance of speed and reliability
- Innovation driven by a scarcity of resources
- Migration of skilled labor from buying to supplying countries (Technopak, 2007).

As years pass since complete quota elimination, companies are provided with a better picture of the new trading environment. A number of changes were expected for the textile and apparel industry post quota, yet the changes have been slow. Reasons for the slowed pace include proactive measures against Chinese imports in terms of safeguards and anti dumping duties. Over the next few years, it is expected that the pace of reforms will be must faster (Technopak, 2007).

In terms of the US textile industry the following factors exist:

- Reorganization, restructuring, downsizing, acquisition, vertical integration
- Firms are trying to achieve economies of scale and expand their services

- Trend toward niche products and diversification
- Growth in technical fibers for sportswear and active wear
- Growth potential in non-apparel markets such as the automobile industry, medicine, telecommunications, and personal and property protection (Shisoo, 2004).

Textile and Apparel Industry Landscape of North Carolina

A current analysis of the North Carolina textile complex and its position in a changing industry was provided by North Carolina State College of Textiles researchers (Cassill et al, 2006). North Carolina State University's College of Textiles conducted a research project with funding from the North Carolina Department of Commerce entitled State of the Union of the Textile Industry in North Carolina: Improving Global Market Competitiveness with Identification and Assistance of Core Competencies. Rather than only focus on the traditional manufacturing sectors of the textile industry, the entire textile value chain from raw materials to retail, intangible value-adding activities, auxiliary industries, and the supporting environment were included in the analysis (Frederick, 2007). Outcomes of the study indicate that North Carolina is still a recognized leader in textile marketing and manufacturing as well as university and industry research and development (Frederick, 2007).

A total of 1,400 textile and apparel locations were identified through the study. These 1,400 establishment employed 111,864 people and produced sales on excess of \$35 billion in 2006 (Frederick, 2006). However due to the privately held nature of 91% of the establishments in North Carolina, the sales figure is an estimate (Frederick, 2007).

A total of 90 of the 100 counties in North Carolina were found to have at least one textile complex company. The study found four geographic clusters in North Carolina that represent approximately 62% of all North Carolina companies represented in the database (Cassill et al, 2006). These clusters were formed due to historical basis and distribution basis and are represented in the Charlotte area, Triad, Hickory Area, and in the Triangle.

In addition to geographic clusters, the study also identified industry segment clusters, as well. They are classified as follows:

- Textile and Apparel Trade Cluster
- Textile and Apparel Distribution Cluster
- Textile and Apparel Creative Innovative Cluster
- Textile and Apparel Post Assembly Customization Cluster
- Textile and Apparel Financial Cluster

The study found that new/emerging clusters can increase productivity, innovation, and stimulate new business opportunities for North Carolina. (Cassill et al 2006) Flourishing companies in North Carolina have the capabilities to participate in new and emerging clusters and are not as concentrated in the traditional textile and manufacturing cluster. Coping companies are becoming more involved in creative and innovative clusters, while potentially vulnerable companies appear to remain vested in traditional textile and apparel manufacturing. Many of the potentially vulnerable companies are not tied specifically to a cluster. The study cited the development of the performance cluster as an avenue for economic development for North Carolina.

Researchers created the North Carolina Textile Complex Database. The database contains 1400 companies which are involved in the development, manufacture, marketing, and distribution of textile products. The database is in Excel format and can be sorted by 90 variables. The database was used for identification and segmentation processes in the research.

Opportunities for Technical Textiles

Technical (performance, industrial, specialty, engineered) textiles present a number of opportunities for companies in the textile industry. It is a dynamic market that is constantly changing and innovating. Due to the broad range of technical textile products and market applications, it is difficult to identify growth and product trends for the sector as a whole. However, all available indications are that the demand for technical textiles in most markets remains strong (Kaufman, 2007). Customer expectations and demand for technical textiles are expected to grow as product applications become better publicized, marketed, and understood. All indications are that the applications and markets for technical textiles in the United States and abroad will continue to evolve and grow (Kaufman, 2007).

CHAPTER III

RESEARH METHODOLOGY

Purpose of Research

The purpose of this research study was to conduct an analysis of the performance textile industry in North Carolina and provide the foundation for building a “performance cluster” in North Carolina. Another purpose of this research was to analyze factors that contribute to or hinder competitiveness in the textile and apparel industry in terms of performance textile applications.

A two phase approach was used to address the research objectives of this study. Phase I included an analysis of the global performance textile industry in addition to the performance textile industry specific to North Carolina. Phase II provided an analysis of growth opportunities and competitiveness issues specific to the North Carolina performance textile complex. Figure 6 provides a framework for the research process.

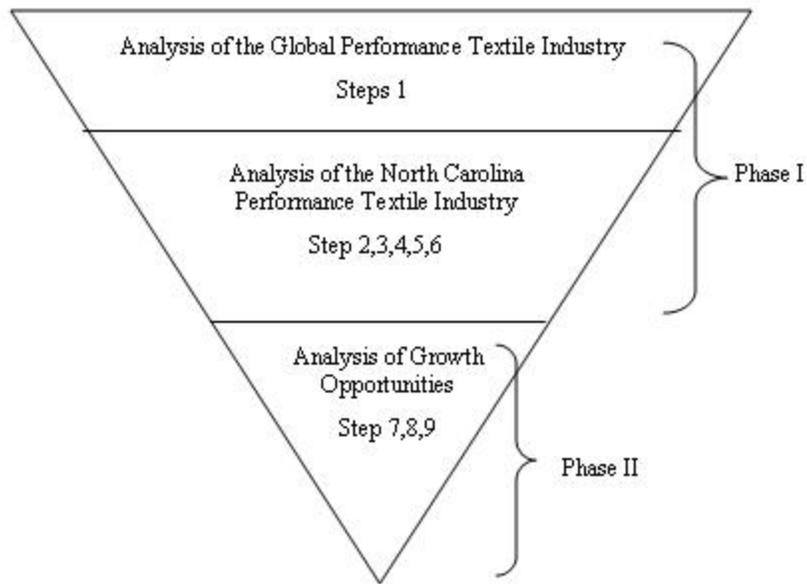


Figure 6 **Research Design.**

Source: Author (Nelson, 2007)

Research Objectives

Research objectives for Phase 1 include key themes associated with understanding the global performance textile industry and its' presence in North Carolina.

Phase I: Exploratory

RO1: To analyze the global performance textile industry including product and market dynamics, shifts in marketing strategies, and industry characteristics using secondary sources.

RO2: To analyze the North Carolina performance textile industry by providing a profile of the performance textile industry using secondary and primary sources in

order to:

RO2A: Understand current industry dynamics;

RO2A1: Number of companies;

RO2A2: Number of counties;

RO2A3: Cluster configuration;

RO2A4: Estimated annual sales;

RO2A5: Employees;

RO2A6: Products produced;

RO2A7: Companies competing.

RO3: To identify North Carolina companies competing in the performance textile industry using appropriate sub-sector definitions.

RO4: To identify the cluster structure and dynamics of performance textile companies.

RO5: To conduct a focus group for validation of RO1-RO4. A focus group session will be used to determine:

RO5A1: Industry requirements

RO5A2: Cluster Formation

RO5A3: Trade and Expertise

RO5A4: Information needed for competitiveness

RO6: To identify and validate opportunistic sub-sectors for further analyses using quantitative and qualitative criteria.

Phase II: Concurrent Triangulation

Deductive Approach

Research objectives for Phase II include key themes associated with understanding sub-sectors with the most economic development and growth potential for North Carolina. Selected sub-sectors included: protection (military), medical, industrial, and geotextile (construction).

RO7: To conduct focus groups with each of the identified growth sub-sectors to determine:

RO7A: Factors that contribute to or hinder competitiveness in the textile and apparel industry in terms of:

RO7A1: Global competitiveness, growth potential, market trends

RO7A2: Innovation, added value, advanced manufacturing

RO7A3: Quality, standards and technical performance

RO7A4: Industry needs

RO8: To validate growth sub-sectors in terms of:

RO8A1: Number of companies;

RO8A2: Number of counties;

RO8A3: Cluster configuration;

RO8A4: Estimated annual sales;

RO8A5: Employees;

RO8A6: Products produced;

RO8A67: Companies competing.

RO9: To refine the variables for adding value and address the dynamics in terms of performance textiles related to the Textile Added Value Curve and Jacob's (2007) Lifecycle of Innovation.

Research Design

Strategy

Mixed Methods

A mixed method approach was used for this research study. The mixed method approach combined both qualitative and quantitative data, as well as, primary and secondary sources for analysis. The concept of mixing quantitative and qualitative methods was developed in 1959 by Campbell and Fiske (Creswell, 2003; Allen, 2005).

The mixed methods approach is most appropriate for this research because to include only quantitative and qualitative methods falls short of major approaches being used today in the social and human sciences (Creswell, 2003). A mixed methods approach allows for a most comprehensive analysis of the research problem because multiple forms of data are collected and analyzed.

Table 2 provides the criteria used for selecting the mixed methods approach. The table shows that the priority for data collection is equal; both qualitative and quantitative data are equally important. The data are integrated as both primary and secondary data are collected, and the theoretical perspective is explicit, a theory guides the research (Creswell, 2003; Allen, 2006).

Table 2 Decision Choices for Determining a Mixed Methods Strategy for Inquiry

<i>Implementation</i>	<i>Priority</i>	<i>Integration</i>	<i>Theoretical Perspective</i>
No Sequence Concurrent	Equal	At Data Collection	Explicit
Sequential–Qualitative first	Qualitative	At Data Analysis	
		At Data Interpretation	Implicit
Sequential–Qualitative first	Quantitative	With Some Combination	

Source: Creswell, J. (2003) *Research design: Quantitative, qualitative, and mixed methods approaches*. Thousand Oaks, CA: Sage Publications

A mixed method approach allows for a theory to guide the framework for the study. The theoretical perspective that is utilized in the research study is Jacobs Strategies for Adding Value (2007). Jacob’s states that innovations are processes through which new concepts and meanings are created and new categories are developed (Jacobs, 2007). His theory is built on the idea that innovations can lead to value-added products. Most simplistically Jacob’s theory states that a firm which does not innovate will rapidly deteriorate and become obsolete (Jacobs, 2007).

Two Phases: Exploratory and Concurrent Triangulation

The research was conducted in two phases. Phase I was exploratory and provided an understanding of the performance textile industry on a global level as well as insight into the North Carolina performance textile complex. Phase I addressed research objectives RO1-

RO6.

Phase II of the study used a concurrent triangulation strategy to collect quantitative and qualitative data simultaneously. This strategy is most appropriate because it offers the ability to confirm, cross-validate, or corroborate findings within a single study (Creswell, 2003). Phase II addressed research objectives RO7-RO9.

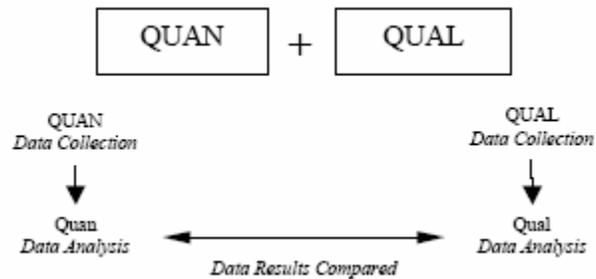


Figure 7 Concurrent Triangulation

Source: Creswell, J. (2003) Research design: Quantitative, qualitative, and mixed methods approaches. Thousand Oaks, CA: Sage Publications.

Phase I: Deductive

Phase I used a deductive research design to collect both qualitative and quantitative data specific to understanding the dynamics of the global performance textile industry and providing breadth to the North Carolina performance textile industry.

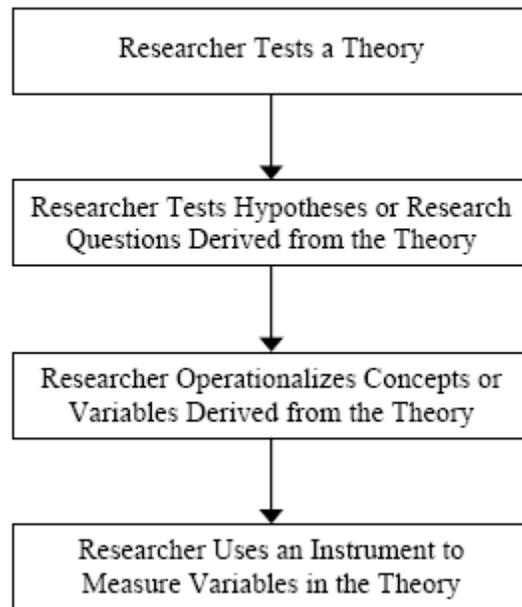


Figure 8 Deductive Model of Phase 1

Source: Creswell, J.W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Method Approaches* (2nd ed). Thousand Oaks, CA: Sage Publications, 132. Reprinted with permission of the author.

Phase II used an inductive research design to serve as a guide for additional focus group topics and structure. This research design was exemplified through collecting qualitative and quantitative data from North Carolina companies competing in growing performance textile sectors. Additionally, a focus group methodology was used to fully understand the dynamics of growth sectors in terms of the performance textile industry in North Carolina.

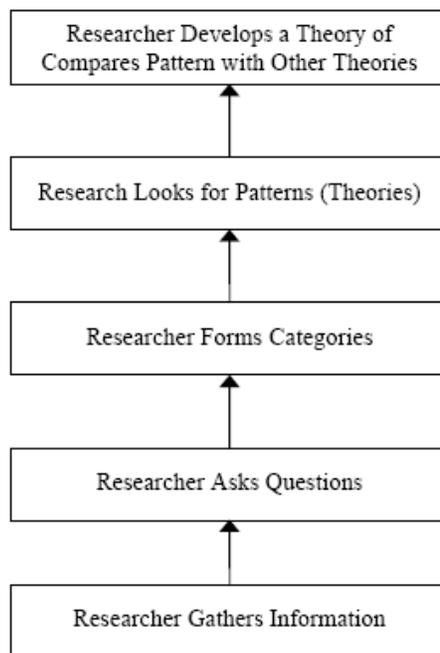


Figure 9 Inductive Model of Phase II

Source: Creswell, J.W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Method Approaches* (2nd ed). Thousand Oaks, CA: Sage Publications, 132. Reprinted with permission of the author.

The end results of both Phase I and Phase II were in depth identification and validation of growing performance sectors in North Carolina, in addition to the implementation of performance markets for use as a global competitive strategy for the North Carolina textile industry.

Data Collection :Phase I (Deductive) Analysis of the Performance Textile Industry

Phase I analyses included the use of primary and secondary data sources to identify:

Step 1: In-depth analyses of the global performance industry

Step 2: Examination of the North Carolina performance textile complex

Step 3: Validation from North Carolina Textile Industry (Focus Group)

Step 4: Segmentation of North Carolina Performance Industry Companies into 12 Sub-

Sector Applications and Clusters

Step 5: Identification of sub-sectors with the most opportunity for North Carolina

Step 6: Validate opportunistic sub-sectors with confirmation from industry, government and academia

Table 3 Phase I Instrument: Primary and Secondary Data Collection

Step	Process	Sources Used	Contribution to Research Objective
1	<ul style="list-style-type: none"> In-depth analyses of the global performance industry 	<ul style="list-style-type: none"> Trade Publications Internet Research Online Databases Market reports Handbooks 	<ul style="list-style-type: none"> Provided a broad understanding of the performance textile complex (RO1)
2	<ul style="list-style-type: none"> Examination of the North Carolina performance textile complex 	<ul style="list-style-type: none"> Literature Horrocks & Anand, 2002 Rigby Associates, 2002 Kilduff & Chang, 2002 	<ul style="list-style-type: none"> Provided a broad understanding of the North Carolina performance textile complex (RO2)
3	<ul style="list-style-type: none"> Validation from North Carolina Textile Industry 	<ul style="list-style-type: none"> Focus Group-Primary data from participants in performance textile industry 	<ul style="list-style-type: none"> Validated RO1 and RO2 (RO5)
4	<ul style="list-style-type: none"> Segmentation of North Carolina Performance Industry Companies into 12 Sub-Sector Applications and Clusters 	<ul style="list-style-type: none"> Literature Horrocks & Anand, 2002 Rigby Associates, 2002 Kilduff & Chang, 2002 North Carolina Textile Complex Database, 2006 	<ul style="list-style-type: none"> Provided an initial depiction of the performance industry's presence and cluster structure in North Carolina (RO3, RO4)
5	<ul style="list-style-type: none"> Identification of sub-sectors with the most opportunity for North Carolina 	<ul style="list-style-type: none"> Compare results from Steps 3-5 Trade publications internet research online databases 	<ul style="list-style-type: none"> Provided direction and a narrowed population for further analysis (RO6)
6	<ul style="list-style-type: none"> Validate Opportunistic Sub-Sectors 	<ul style="list-style-type: none"> Academia Industry Experts NC Commerce Steering Committee 	<ul style="list-style-type: none"> Validated sample for further research (RO6)

Source: Adapted by H. Nelson (2008) from R. Allen (2005); Nowell (2005).

Step 1- In-depth analyses of the global performance industry

Secondary data sources provided information about six specific areas of the global performance industry.

- a) Overview of Production and Market Dynamics
- b) Market Dynamics and History of Performance Textiles
- c) Shift in Marketing Strategies
- d) Industry Characteristics
- e) Profile of the Performance Industry in North Carolina
- f) Sub-sector Definitions and Cluster Dynamics in North Carolina

Resources used to complete Step 1 analyses are included in Table 4.

Table 4 *Resources Used for Secondary Data*

Sources	Contribution
Research Publications (Trade Journals)	
<i>The US Market for Technical Textiles</i>	Identified opportunities in performance textiles for the United States.
<i>An Assessment of US Comparative Advantage in Technical Textiles from a Trade Perspective</i>	Identified competitive advantage and infrastructure needed to compete in performance textiles.
<i>Cluster and the New Economics of Competitions</i>	Identified cluster theory and methods for establishing successful clusters.
<i>Location, Competition, and Economic Development: Local Clusters in a Global Economy</i>	Discussed cluster development as a means for achieving competitive advantage.
Industry and Trade Handbooks	
<i>The Handbook for Technical Textiles</i>	Provided background and definitions for performance textiles and sub-sector applications.
<i>Technical Textiles and Industrial Nonwovens Forecast to 2010</i>	Provided market specifics, growth opportunities and sub-sector development. Adapted sub-sector growth opportunities to North Carolina.
Government Data	
<i>State of the Union of the Textile Industry in North Carolina: Improving Global Market Competitiveness with Identification and Assistance of Core Competencies</i>	Provided fundamental research of the North Carolina textile complex and identified growth industries.
<i>OTEXA</i>	Provided trade data.
<i>Fiber Economics Bureau</i>	Provided information in terms of identifying manufactured fiber trends.
<i>North Carolina Textile Complex Database</i>	Provided company information used to segment for performance sub-sector development in North Carolina.

Source: Author (Nelson 2007).

Step 2- Examination of the North Carolina performance textile complex

Using the updated 2007 North Carolina textile industry database (developed for the “State of the Union” 2006 study), an examination of those performance textile companies that supply, manufacture, market/distribute, and restore (launders/cleaners) was conducted.

The North Carolina Textile Complex Database is in EXCEL format with a total of 1,500 companies represented. Companies in the database can be searched and sorted using 90 variables. North Carolina textile companies in the database include:

- Traditional manufacturing (fiber, yarn, fabric, finished goods)
- Distribution and transportation/logistics
- Marketing and design
- Wholesale and retail
- Development activities
- Machinery
- Labeling/ticketing
- Research/testing services
- E commerce (B to C)
- Dyeing and finishing
- Other auxiliary services

1. A preliminary listing of North Carolina companies competing in the performance sector was compiled using secondary literature and industry interviews. This listing was used to provide the researchers with an initial understanding of the performance textile

landscape in North Carolina.

2. The North Carolina Textile Database was then used to provide a more complete approach to identifying performance textile companies in North Carolina. Companies were chosen using the following techniques:

- Using the search tool, companies were selected for placement in the performance industry based on components of the product produced, product offered, application, and end use market.
- Matching products and end markets with those described in the definitions of each sub-sector, companies competing in the performance textile industry were identified.
- Using county information and zip code data, the performance textile companies were then placed in a dot map of North Carolina. The dot map provided visual confirmation of existing geographic clusters.

3. Focus group discussions further validated company placement in the performance industry. Revisions and addition of company placement in the North Carolina performance industry were conducted prior to the focus group, with validation of focus group participants. The North Carolina Textile Complex database was updated July 2007 and used to complete the revisions and additions.

Step 3- Validation from North Carolina Textile Industry (Focus Group)

Identification of potential focus group participants and identification of key questions and issues to be discussed at the focus group meeting

Qualitative data for Phase I Step 3 was collected using a focus group methodology. A focus group is an interview conducted by a trained moderator in a nonstructured and natural

manner with a small group of respondents (Malhotra, 2004). For Phase I focus groups, a dual moderator approach was used. One moderator was responsible for the smooth flow of the session, while the other (the researcher) ensured that specific issues were discussed (Malhotra, 2004). Dual moderators were used to (1) establish rapport with the group, (2) state the rules of the group interaction, (3) set objectives, (4) probe the respondents and provoke intense discussion in the relevant areas; and (5) attempt to summarize the group's response to determine the extent of the agreement (Malhotra, 2004).

A knowledgeable facilitator was selected to serve as the focus group moderator. The facilitator's experience in the performance textile industry consists of approximately 40 years in the marketing of synthetic fibers.

The main objective of a focus group methodology is to gain insights by listening to a group of people from the appropriate target population to discuss topics of interest to the researcher. Specifically, the objective of the Phase I focus group was to address the dynamics and landscape of the North Carolina performance textile industry in a broad and general manner. A key benefit of using a focus group methodology is that it is the most important qualitative research procedure (Malhotra, 2004). The following procedure was followed for planning and conducting the focus groups:

1. Determine the objectives of the research project and define the problem.
2. Specify the objectives of qualitative research.
3. State the objectives/questions to be answered by focus groups.
4. Develop a moderator's outline.
5. Conduct the focus group interviews.

6. Analyze the data.

7. Summarize the findings and plan follow-up research or action (Malhotra, 2004).

A convenience sample was used for Step 3. Convenience sampling attempts to obtain a sample of convenient elements (Malhotra, 2004). Using Malhotra's method, the interviewer is responsible for the selection of the sampling units. Convenience sampling was chosen because it is the least expensive and least time consuming of all sampling techniques (Malhotra, 2004). Convenience samples are most often used with focus groups.

The companies for the sample were selected from the population of fiber/yarn, textile, apparel, and retail firms that compete in the performance textile industry in North Carolina. All sectors of the performance textile industry supply chain were chosen in order to look at the dynamics of the complete complex, thus the population included companies that supply, produce, market, and sell performance textile products.

Potential focus group participants were identified by conducting short interviews at trade shows and information sessions. Short interviews and information requests were conducted at the following events.

Table 5 Information Sources

Event	Location	Date
Mega-Tex Trade Show	Atlanta, GA,	October 31 to November 1, 2006
MAGIC Trade Show	Las Vegas, NV	February 13-16, 2007
The Innovations in Nanotechnologies, Composites, and Sports Materials Symposium	Atlanta, GA	April 11-12, 2007
NC State College of Textiles Research Day Graduate Student Poster Session	Raleigh, NC	April 13, 2007

Source: Author (Nelson, 2007).

Business cards were collected of interested personnel and an Excel spreadsheet was created of potential focus group participants. Additional focus group participants were identified by steering committee members. Members and affiliations are included in Table 6.

Table 6 Steering Committee Members

North Carolina State College of Textiles	
Nancy Cassill	Professor, Project PI
Blanton Godfrey	Dean, Project Co-PI
Trevor Little	Department Head, Co-PI
Holli Nelson	Graduate Student
NC Department of Commerce	
Peter Cunningham	Director, International Trade Division
Glenn Jackman	Business Development Manager (Textiles)
Tammy Lester	Economist
Other Advisors	
Jim Leonard	Former OTEXA Assistant Secretary, USDOC

Source: Author (Nelson, 2007)

Primary and secondary data was used to identify relevant focus group topics. Data sources are included in Table 7.

Table 7 Data Sources for Focus Group Topics

Method	Source	Date
Personal Interviews	Mega-Tex Trade Show	October 31-November 1, 2006
Personal Interviews	MAGIC Trade Show	February 13-16, 2007
Personal Interviews	Tammy Lester, NCDOC	2006-2007
Personal Interviews	Nancy Cassill, Research Advisor	2006-2007
Personal Interviews	Steering Committee	2006-2007
Personal Interviews	John Anderson, Moderator	2007
Educational Seminars	Mega-Tex, MAGIC	Attended 2006
Literature Reviews	<i>The US Market for Technical Textiles</i>	Reviewed 2006-2007
Literature Reviews	<i>An Assessment of US Comparative Advantage in Technical Textiles from a Trade Perspective</i>	Reviewed 2006-2008
Literature Reviews	<i>Cluster and the New Economics of Competitions</i>	Reviewed 2006-2009
Literature Reviews	<i>Location, Competitions, and Economic Development: Local Clusters in a Global Economy</i>	Reviewed 2006-2010
Literature Reviews	<i>Technical Textiles and Industrial Nonwovens: World Market Forecasts to 2010</i>	Reviewed 2006-2011
Literature Reviews	<i>Handbook of Technical Textiles</i>	Reviewed 2006-2012

Source: Author (Nelson, 2007).

Communication with focus group participants

Using identified focus group participants segmented by sub-sector, an email invitation followed by a mailed invitation to potential focus group participants was sent to approximately 60 companies in the North Carolina performance textile industry (see Appendix A for all communication to participants). Email communication was sent Thursday, May 3, 2007. Mailed invitations were sent Monday, May 7, 2007. A logistics email including directions, topics for discussions, and a participant listing was emailed to all confirmed attendees. The logistics email was sent Wednesday, May 30th 2007.

The response rate for the focus group was 56%. Focus group participants are included in table 8.

Table 8 Phase I Sample Selection Focus Group Participants

Name	Company
Peggy Pickett	AATCC
Tony Webber	Adaptive Control
Mark Hatton	American and Efird
Tracey Campbell	American Fibers and Yarns
Stephanie Norris	ATEX Technologies
Robert Daniel	Basofil
Frank Bell	Bell Associates
Alex Whitley	Contempora Fabrics
Gary Raines	Cotton Inc
Janet O'Reagan	Cotton Inc
Bill Hunneke	Domestic Fabrics
Fred Hunneke	Domestic Fabrics
Felipe A Ramirez	DSM
Jose Merino	Duke Energy
Steven Sheek	Duke Energy
Hal Bates	Glen Raven
Gordon Magee	Goulston Technologies
Sally Kay	Hosiery Association
Dan St. Louis	Hosiery Technology Center
Mike Cheek	Huntsman International
Bill DiIanni	ITG

Name	Company
Jim Booterbaugh	National Spinning
Teresa Bouchnett	NCMBC
Manfred Wentz	Oeko Tex
Doug Woolweaver	Parkdale
Harold Edwards	Pharr Yarns
Terry Montgomery	Precision Fabrics Group
Jeff Bruner	Quantum Group
John Wilson	Quantum Group
Kim Hall	RadiciSpandex
CP Davis	Shuford Mills
Mike Carter	Spectrum Dyed Yarns
Derek Gun	Unifi

Additional attendees included North Carolina Department of Commerce personnel and North Carolina State researchers and faculty.

Variable Measurement and Instrument Development

One instrument was developed for Phase I. The instrument served as the moderator's guide for the focus group. The instrument (moderator's guide) consisted of four parts. The moderator's guide is included in Appendix A2. Each part is outlined as follows:

- Section 1: Industry requirements
- Section 2: Cluster formation
- Section 3: Trade and expertise
- Section 4: Information needed for competitiveness

Section 1 questions were asked to provide the researcher with an understanding of the requirements needed to compete in the performance industry. Section 2 questions were used to test and confirm the cluster formation of performance textile companies in North Carolina. Section 3 addressed issues which were specific to trade and sourcing information. Section 4 allowed participants to discuss factors needed for competitiveness and the state of the performance industry in North Carolina.

Data Analysis

Data analysis for qualitative data obtained from the focus group was specific to the processes used to analyze focus group data outlined by Malhotra (2004). In order to fully analyze the data, extensive discussion documentation and interpretation was needed. Once focus group discussions were completed, the researcher analyzed the results. Due to the small number of participants in the focus group setting, analysis did not reflect percentages or

frequencies. Analysis was based on:

- Specific comments or findings
- Consistent responses
- New ideas
- Concerns
- Confirmation
- Body language and manner (Malhotra, 2004).

Upon analysis, data was analyzed to identify key issues related to the performance textile industry in North Carolina. Data was integral in forming the Phase II focus group instrument and for selecting opportunistic sub-sectors for further analysis.

In terms of confidentiality, all data and analysis were coded. Participant responses are not linked to specific company representation. All responses were coded and recorded to provide general answer to topic discussions.

Step 4- Segmentation of North Carolina Performance Industry Companies into 12 Sub-Sector Application and Clusters

The 12 sub-sectors, end uses, and application are included in Table 9.

Table 9 Performance Textile Sub-sectors, End-Uses, and Applications

Division	End Uses	Application
Agriculture	agriculture, horticulture, forestry and fishing	cover, protection, collection, fishing, tying
Construction	building and construction	protection, display, textile constructions, building components, reinforcements
Apparel	technical components of shoes and clothing	shoe components, insulation, structure, sewing, products
Geotextiles	geotextiles and civil engineering	stabilization, separation, drainage, soil reinforcement, erosion control, linings
Home Furnishings	components of furniture, household textiles, and floor coverings	carpet components, furniture components, cleaning, filtration, ticking, composites
Industrial	filtration, cleaning and other industrial materials	filtration, MRG's, cleaning, lifting, pulling, electrical, components, other
Medical	hygiene and medical	cleaning, cover stock, wound care, protection
Transportation	automotive, marine, railways, and aerospace	MRGs, safety, trim, insulation, floor covering, protection, composites, other
Packaging	packaging	bulk packaging, disposable, tying, other
Protection	personal and property protection	particulate protection, chemical protection, flame retardant, cut resistant, outdoor use, other
Sport	sport and leisure equipment	luggage components, sports equipment, camping equipment, other
Environmental	environmental protection	products extracted from the above

Source: Rigby, D. (2002). *Technical Textiles and Industrial Nonwovens: World Market Forecasts to 2010*. Manchester: David Rigby Associates Limited.

1. North Carolina companies identified as performance industry participants were segmented into corresponding sub-sector applications, as identified in Table 2.

- Each company was examined using its name, company description, and its placement in the supply chain.
- Using the information gathered from a company's name, description, and placement in the supply chain, segmentation was identified based on product components, products produced, application, and end use markets.
- However, some companies may exist in more than one sub-sector. If a company's

description included multiple product categories and end-use markets, the company was placed in all appropriate sub-sectors.

- While one company may be represented in more than one sub-sector, that company is only counted once when calculating total North Carolina performance industry statistics.
- Secondary literature and validations communicated at the focus group were also used to segment companies into appropriate sub-sectors.

All components of Stage 1 were guided by the project's Steering Committee. The committee consisted of North Carolina State College of Textiles researchers, North Carolina Department of Commerce personnel, and a former US Department of Commerce official.

Table 4 provides Steering Committee information.

Meetings were held throughout the duration of the research project to discuss progress and development of creating the performance textile cluster (March 2, March 16, 2007).

- March 2, 2007
 - Initial meeting of Steering Committee. Preliminary findings were discussed and focus group representation was identified.
- March 16, 2007
 - Follow up from initial Steering Committee meeting. Project updates were discussed.
 - Pros and cons of terminology (performance versus technical) were discussed. Focus group representation was discussed further.

Step 5: Identification of sub-sectors with the most opportunity for North Carolina

Specific criteria were developed for the identification of sub-sectors with the most growth opportunity for the North Carolina performance textile industry. This criterion included:

Quantitative (Established Sales and Growth)

- Estimated sales dollars (annual)
- Number of companies
- Estimated sales per company
- Number of employees
- Estimated sales per employee

Qualitative

- Global growth Opportunity
- Market dynamics
- Consumer preferences
- Industrial/Government support
- Market placement
- Level of innovation/added value needed

Validation

Table 10 provides the quantitative data used for identification of sub-sectors with growth opportunities for North Carolina. Each column (excluding rank) in the table was weighted using a scale of 1 to 5. A weighting of 1 was associated with the lowest growth opportunity

while a weighting of 5 was associated with the most growth opportunity. Columns used for quantitative weighting included:

- Estimated sales dollars (annual)
- Number of companies
- Estimated sales per company
- Number of employees
- Estimated sales per employee

Weights from each column were then averaged. Quantitative weighted averages were combined with qualitative averages to determine the top five growth sectors for further analyses.

Table 10 *Quantitative Justification for Growth Opportunities*

<i>Quantitative</i>													
Sub-sector	Sales \$ (estimated)	Sales Rank	Sales Weight	Number of Companies	Company Rank	Company Rank	Sales Per Company	Sales per Company Rank	Number of Employees	Employee Rank	Sales Per Employee	Employee Sales Rank	Weight Average
Industrial	\$7,887,113,398	1	5	273	1	5	\$28,890,525.27	5	29097	5	\$271,062.77	2	4.4
Transportation	\$3,367,312,345	2	4	92	2	4	\$36,601,221.14	5	7482	4	\$450,055.11	4	4.2
Apparel	\$2,368,699,845	3	4	73	5	3	\$32,447,943.08	5	6251	3	\$378,931.35	3	3.6
Protection	\$1,607,474,400	4	3	91	3	4	\$17,664,553.85	3	4744	2	\$338,843.68	3	3
Medical	\$1,513,621,608	5	3	69	6	3	\$21,936,545.04	4	6117	3	\$247,445.09	2	3
Sport	\$1,390,519,811	6	3	69	6	3	\$20,152,461.03	4	4341	2	\$320,322.46	3	3
Home Furnishings	\$1,123,668,992	7	3	90	4	4	\$12,485,211.02	2	4520	2	\$248,599.33	2	2.6
Packaging	\$749,670,067	8	2	60	7	3	\$12,494,501.12	2	3621	2	\$207,033.99	2	2.2
Construction	\$726,213,045	9	2	32	11	2	\$22,694,157.66	4	1324	1	\$548,499.28	5	2.8
Environmental	\$346,993,650	10	1	36	9	2	\$9,638,712.50	1	1293	1	\$268,363.23	2	1.4
Agriculture	\$229,012,542	11	1	35	10	2	\$6,543,215.49	1	1052	1	\$217,692.53	2	1.4
Geotextiles	\$227,572,542	12	1	40	8	2	\$5,689,313.55	1	1111	1	\$204,835.77	2	1.4
Weights:													
	Sales \$			Company			Sales per company		Number of Employees		Sales per employee		
	Sales 5,000,000,000	5		100+	5		25,000,000+	5	9000+	5	500,000-600,000	5	
	Sales 2,000,000,000	4		75-100	4		20,000,000-25,000,000	4	7000-9000	4	400,000-500,000	4	
	Sales 999,999,999	3		50-75	3		15,000,000-20,000,000	3	5000-7000	3	300,000-400,000	3	
	Sale 500,000,000	2		50-25	2		10,000,000-15,000,000	2	3000-5000	2	200,000-300,000	2	
	Sales 200,000,000	1		0-25	1		5,000,000.00-10,000,000	1	1000-3000	1	100,000-200,000	1	

Source: Author (Nelson, 2007)

Table 11 provides the qualitative data used for identification of sub-sectors with growth opportunities for North Carolina. Each column in the table was weighted using a scale of .1 to .5. A weighting of .1 was associated with the lowest growth opportunity while a weighting of .5 was associated with the most growth opportunity. Columns used for qualitative weighting included:

- Global growth Opportunity
- Market dynamics
- Consumer preferences
- Industrial/Government support
- Market placement
- Level of innovation/added value needed

Table 11 Qualitative Justification for Growth Opportunities

	Horrocks & Anand, 2000	Weight	Rigby & Associates, 2002 (2010 Volume Growth Forecast)	Weight	Rigby & Associates, 2002 (2010 Value Growth Forecast)	Weight	Technical Textile Markets Symposium 2002-2007	Weight	Average
Sub-sector									
Industrial	3	0.1	4	0.2	5	0.2	2	0.4	2.3
Transportation	3	0.1	3	0.2	1	0.2	3	0.4	1.4
Apparel	1	0.1	3	0.2	3	0.2	0	0.4	1.3
Protection	4	0.1	4	0.2	3	0.2	5	0.4	2.3
Medical	3	0.1	4	0.2	4	0.2	4	0.4	2.3
Sport	3	0.1	3	0.2	3	0.2	0	0.4	1.5
Home Furnishings	2	0.1	2	0.2	2	0.2	0	0.4	1
Packaging	3	0.1	3	0.2	4	0.2	0	0.4	1.7
Construction	2	0.1	5	0.2	5	0.2	3	0.4	2.5
Environmental	2	0.1	5	0.2	5	0.2	1	0.4	2.3
Agriculture	2	0.1	3	0.2	4	0.2	0	0.4	1.6
Geotextiles	4	0.1	5	0.2	5	0.2	5	0.4	2.9

Source: Author (Nelson, 2007)

Average weights for qualitative and quantitative data were combined to determine the top

five sub-sectors for further identification and validation in Phase II. Tables 12 and 13 identify sub-sectors with the most growth opportunity for North Carolina

Table 12 *Sub-Sector Selection Averages (Quantitative and Qualitative)*

Sub-Sector Selection	Quantitative Average	Qualitative Average	Total
Sub-sector			
Industrial	4.4	2.25	6.65
Transportation	4.2	1.325	5.525
Apparel	3.6	1.3	4.9
Protection	3	2.175	5.175
Medical	3	2.2	5.2
Sport	3	1.5	4.5
Home Furnishings	2.6	1	3.6
Packaging	2.2	1.7	3.9
Construction	2.8	2.425	5.225
Environmental	1.4	2.275	3.675
Agriculture	1.4	1.6	3
Geotextiles	1.4	2.775	4.175

Source: Author (Nelson, 2007)

Table 13 *Sub-Sector Selection Totals and Rank*

Sub-sector	Total	Rank
Industrial	6.65	1
Transportation	5.525	2
Construction	5.225	3
Medical	5.2	4
Protection	5.175	5
Apparel	4.9	6
Sport	4.5	7
Geotextiles	4.175	8
Packaging	3.9	9
Environmental	3.675	10
Home Furnishings	3.6	11
Agriculture	3	12

Source: Author (Nelson, 2007)

NC State researchers validated the criteria for sub-sector sample selection and refined the listing to:

- Industrial

- Construction
- Medical
- Protection (Military)

Once the listing of opportunistic sub-sectors was validated, additional cluster maps were created in order to more accurately identify cluster structure. Maps were created using a high resolution image of North Carolina.

Step 6: Focus Group Sample Selection for Phase II

Once the sub-sector (industrial, construction, medical, protection) sample was selected, the process of sample selection in terms of company representatives for additional focus groups was necessary. The sample was used to further address competitiveness topics in Phase II.

A convenience sample was used for Step 6. Convenience sampling attempts to obtain a sample of convenient elements (Malhotra, 2004). Using Malhotra's method, the interviewer is responsible for the selection of the sampling units. Convenience sampling was chosen because it is the least expensive and least time consuming of all sampling techniques (Malhotra, 2004). Convenience samples are most often used with focus groups.

The companies for the sample were selected from the population of fiber/yarn, textile, apparel, and retail firms that compete in the performance textile industry in North Carolina. All sectors of the performance textile industry supply chain were chosen in order to look at the dynamics of the complete complex, thus the population included companies that supply, produce, market, and sell performance textile products. The population was selected from:

- NC DOC Textile Team Interest Groups
- Requests from 2007 Inaugural Performance Textile Focus Group
- NCSU COT Research Open House Contact Listing
- NCSU COT Distance Education Contact Listing
- NCSU Textile Addresses Listing
- NC DOC Textile Team Meeting Proceedings
- NC Company Listing from Outdoor Retailer Trade Show
- Business Development Contacts courtesy of Glen Jackman

The North Carolina Performance Textile Database (2007) was used to validate the population. The database provided information specific to sub-sector representation, import/export activities, product mix, and line of business.

An adapted sample selection process similar to that used by Cesca (2005), Jones (2005), Nowell (2005), and Allen (2006) was used to determine the appropriate sample for each additional focus group. Sample selection process steps included:

1. Compile all population data. Create a spreadsheet with company name, market segment, and contact information. N=347
2. Cross reference company information with 2007 North Carolina Performance Textile Database for representation validation. N=295
3. Determine if companies import/export performance products. Exclude companies who are not involved in importing/exporting as this is an integral factor of global competitiveness. N=224
4. Determine product mix and line of business. Exclude companies who are

not directly involved in the production, marketing, or selling of industrial textile applications. (Service organizations, testing facilities, and research facilities were included.) At this time companies were placed in appropriate focus group sections corresponding to product mix and line of business.

N=184

*Note: During population compilation, if a company was not represented in the North Carolina Performance Textiles Database (2007), but fit in an appropriate growth sub-sector (medical, protection, industrial, or construction), the company was added to the database. Updated statistics were provided for the North Carolina Performance Textiles Database, thus creating a 2008 version of the listing. This process met the requirements needed for research objective 8.

Sample 1: Industrial

Approximately 57 companies were invited to the industrial textile focus group. Eight companies confirmed to attend the focus group and four telephone interviews were conducted. The response rate for the industrial focus group was 21%. The confirmed sample is shown in Table 14.

Table 14 *Industrial Focus Group Sample Selection*

Industrial	INDA
Industrial	National Spinning
Industrial	DAK Americas LLC
Industrial	The Quantum Group, Inc
Industrial	American Truetzshler
Industrial	US DOC
Industrial	Fiber Visions
Industrial	Fiber Dynamics
Industrial	American and Efird
Industrial	Invista
Industrial	Shuford Mills
Industrial	Service Thread Company

Sample 2: Medical

Approximately 49 companies were invited to the medical textile focus group. Twelve companies confirmed to attend the focus group and one telephone interview was conducted. The response rate for the medical focus group was 26%. The confirmed sample is shown in Table 15.

Table 15 *Medical Focus Group Sample Selection*

Medical	Karl Mayer
Medical	Hosiery Technology Center
Medical	AATCC
Medical	Parkdale
Medical	Carolina Silver
Medical	PGI
Medical	Domestic Fabrics
Medical	Laam Science
Medical	Holt Hosiery
Medical	Carolina Narrow Fabrics
Medical	UNIFI
Medical	OTEXA
Medical	Quill Medical

Sample 3: Protection (Military)

Approximately 44 companies were invited to the protective textile focus group. Fourteen companies confirmed to attend the focus group and one telephone interview was conducted. The response rate for the protective focus group was 34%. The confirmed sample is shown in Table 16.

Table 16 *Protection Focus Group Sample Selection*

Protection	Spectrum Dyed Yarns
Protection	Hanes Brands
Protection	Glen Raven
Protection	International Market Solutions
Protection	Cocono
Protection	Carolina Mills
Protection	Burlington Labs
Protection	Daikin America, Inc
Protection	NCMBC
Protection	Military Foundation
Protection	Saab Group
Protection	Defense & Security Technology Accelerator
Protection	Domestic Fabrics
Protection	Longworth Industries/Polarmax

Sample 4: Construction (Geotextile)

Approximately 34 companies were invited to the construction textile focus group. Eight companies confirmed to attend the focus group, with one company providing two representatives and one telephone interview was conducted. The response rate for the construction focus group was 32%. The confirmed sample is shown in Table 17.

Table 17 Construction Focus Group Sample Selection

Construction	US GreenFiber
Construction	Goulston Technologies, Inc
Construction	Carriff Corporation
Construction	PPG Industries
Construction	PPG Industries
Construction	DSM Dyneema
Construction	Engineering Tectonics
Construction	US DOC-OTEXA
Construction	Geosynthetic Corp
Construction	Hanes Geo Composites

Sample Validation

Each focus group sample was validated by industry representatives.

Phase II Concurrent Triangulation (Inductive)

Data Collection: Phase II

Companies that were identified for participation in the study’s focus groups were contacted via email. Similar emails (Appendix C5) were sent to all contacted companies. Slight differences included specific sub-sector name, date, and time. The letter explained the purpose of the study, the partnership with the North Carolina Department of Commerce, and general planned focus group topics.

In order to increase the response rate, the following steps were followed. Email

invitations were personalized and addressed to specific individuals. Additionally, follow-up emails were sent. A nonmonetary reward was offered to all participants. The reward provided access to all findings from the research study. Malhotra (2004) provided these techniques.

Follow-up emails were sent and phone calls were made in order to provide further information and explanation in terms of the purpose and objective of the focus groups. The email and telephone communication method was chosen due to the timing of the focus group and the need for a quick turn around time in terms of inviting additional participants.

Invitees who were interested in participating but had scheduling conflicts were given the option of participating in a telephone interview. Seven telephone interviews were conducted with duration of 1 hour each. Telephone interviews also served as a screening procedure. The moderator's guide was revised based on telephone interview responses.

Research Questions

The specific research question that was addressed in Phase II focus groups includes RO7.

This research question addressed:

1. Factors that contribute to or hinder competitiveness in the performance textile industry in terms of:

- a. Global competitiveness
- b. Growth potential
- c. Market trends
- d. Innovation, Added Value
- e. Advanced Manufacturing
- f. Quality Standards and Performance

g. Industry Needs

Inductive Logic

Inductive logic was used for qualitative data collection in Phase II. Qualitative data was collected using a focus group methodology. The focus group methodology for Phase II followed the same procedure as Phase 1 Step 3.

Specifically, the objective of this study's focus group was to address and identify factors that contribute or hinder competitiveness in each of the selected sub-sectors (industrial, protection, medical, and construction).

Variable Measurement and Instrument Development

Four instruments were developed for Phase II. Each instrument served as the moderator's guide for specific focus groups. Appendix D: 11 includes the instrument used for the focus groups. The instruments were fundamentally the same. Minor differences included timely topics that were sub-sector specific.

Each instrument was reviewed by industry experts (NCSU, NC DOC, and the moderator) and validated prior to the focus groups. Additionally, seven telephone interviews served as a screening process and helped in determining appropriate question wording and the necessity of certain questions. Five questions were revised or omitted based on telephone interview and expert validation feedback.

The instrument (moderator's guide) consisted of four parts. Each part is outlined as follows:

- Section 1: Global competitiveness factors, growth potential, and market trends

- Section 2: Innovation, added-value, advanced manufacturing
- Section 3: Quality, standards, technical performance
- Section 4: Industry needs, recommendations

Section 1 questions were asked to provide the researcher with an understanding of the current state of the sector. Section 2 questions were used to determine the level of innovation used by each sub-sector and to track that innovation on Jacob's (2007) Lifecycle of Innovation. Section 3 addressed issues which were dynamically discussed in the inaugural focus group in order to provide further insight into the need for regulated standards, quality assurance, and technical performance. Section 4 allowed participants to candidly discuss industry and sub-sector needs, as well as provide recommendations for further focus group topics.

Data Analysis

Data analysis for qualitative data obtained from the focus group was specific to the processes used to analyze focus group data as outlined by Malhotra (2004). Data analysis for Phase II followed the same process as analysis in Phase 1 Step 3. Furthermore, all data and analysis were coded. Participant responses are not linked to specific company representation. All responses were coded and recorded to provide general answer to topic discussions.

Upon analysis, data was analyzed to identify competitiveness issues specific to industrial, protection, medical, and construction textile markets. Data was then incorporated and plotted against Jacob's (2007) Lifecycle of Innovation model and the Textile Added Value Curve (2006). Research objective 9 (to refine the variables for adding value and address the dynamics in terms of performance textiles related to the Textile Added Value Curve and

Jacob's (2007) Lifecycle of Innovation) was completed through this process.

Operational Definitions

Variables discussed in the focus group setting are defined below. These variables were defined in order to remain consistent when analyzing participant responses. Providing consistent definitions of variables is important, so bias could be eliminated when participants questioned the meaning of the variables (Allen, 2006). Corresponding instrument questions/topics (moderator's guide) are listed with appropriate definitions.

Agriculture textiles- Textiles used in agriculture, horticulture, aquaculture, and forestry (Horrocks & Anand, 2000.) [Section 1, Q2-A, B, C, D]

Construction textiles- Textiles used in building and construction (Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D; Moderator Guide D]

Added Value (or value innovation)- Based on the ambition to dominate the market by offering a tremendous leap in value (Kim & Mauborne, 1998) [Section 2, Q4,9,10- A,B,C,D]

Competitive advantage- Is 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). [Section 1,Q4,5-A,B,C,D]

Environmental textiles- Textiles used in environmental protection (Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D]

Geotextiles- Textiles used in geotextiles and civil engineering (Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D; Moderator Guide D]

Home furnishings textiles- Technical components of furniture, household textiles, and

floorcovering (Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D]

Industrial textiles- Textiles used in filtration, conveying, cleaning, and other industrial uses (Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D; Moderator Guide C]

Innovation- Something new, which is presented in such a way that the value will be determined by the selectors (Jacobs, 2007). [Section 2, Q3,4,5,6,7,8-A,B,C,D]

Medical textiles- Textiles used in hygiene and medical products (Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D; Moderator Guide B]

Performance apparel textiles- Technical components of footwear and clothing (Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D]

Packaging textiles- Textiles used in packaging products (Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D]

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 “technical textiles” definition from Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D]

Protection textiles- Textiles used in personal and property protection (Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D; Moderator Guide A]

Sport textiles- Textiles used in sport and leisure (Horrocks & Anand, 2000).

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). [Section 1, Q2-A, B, C, D]

Transportation textiles- Textiles used in automobiles, shipping, railways, and aerospace

(Horrocks & Anand, 2000). [Section 1, Q2-A, B, C, D]

CHAPTER IV

RESULTS

The results of Phase I data collection were analyzed according to the procedure outlined in Table 3 *Phase I Instrument: Primary and Secondary Data Collection* (Chapter 3). The following results begin with identification of the performance textile industry globally in order to identify the performance industry in North Carolina. Results for Phase I include the identification and placement of the performance textile industry in geographic clusters throughout the state and ends with identification of growth clusters for further validation in Phase II.

Phase I Results: Identification of the Performance Textile Industry

Steps 1-2: In depth analysis of the global performance textile industry and Examination of the North Carolina textile complex

a) Overview of Production and Market Dynamics

Performance textiles are 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). Using TechTextil’s (2002) classification system adapted from Rigby Associates, 12 main application areas (“sub-sectors”) of performance textiles have been identified. Table 2 (p. 12) provides brief definitions of each performance textile sub-sector.

Performance textiles have a much wider scope of economic activity than that of traditional textiles. Figure 1 provides a visual depiction of the Performance Industry Value

Chain. The 12 sub-sectors representing performance textiles are surrounded by supporting industries and suppliers. Supporting industries are critical to the performance industry and its growth opportunities.

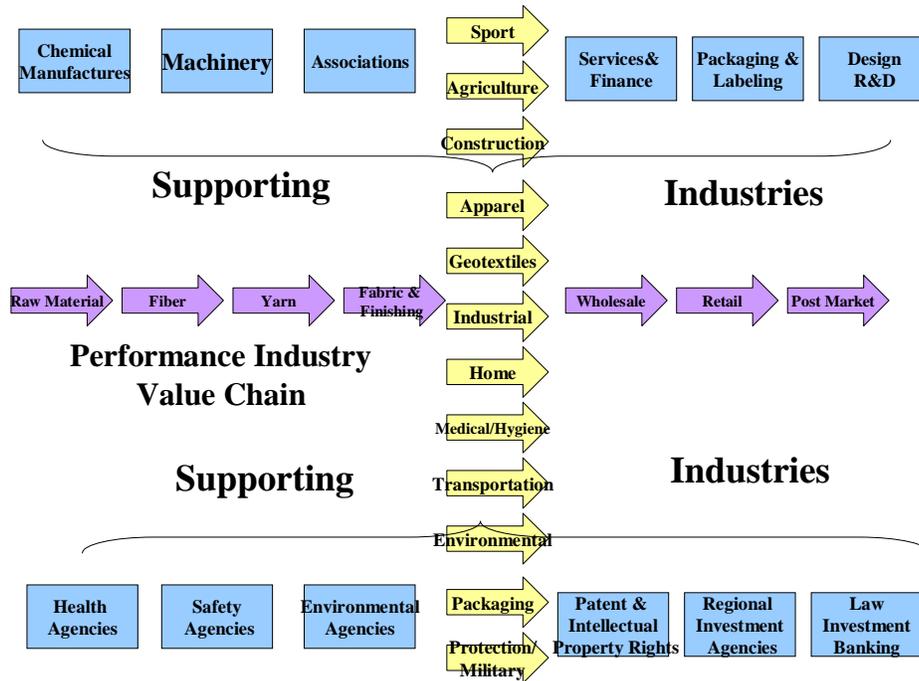


Figure 10 Performance Industry Value Chain

Source: Extended Textile Value Chain. Frederick, S.& Nelson, H. (2007).

In terms of the value chain, many innovations in the performance textile industry derive from raw material and fiber producers in the textile industry. Developments in machinery technologies and product innovation have had a significant impact on the quality requirements of man-made fibers for performance textiles (Morris & Wagneur, 2007).

The main synthetic fibers for the performance textile industry are derived from fossil fuels, namely oil and gas, and include polyester staple and filament, polyamide filament,

acrylic staple, and polypropylene staple and filament (Morris & Wagneur, 2007). End uses for synthetic fibers in the performance textile industry are quite diverse and most dependent on function. For polyester fiber, the main end uses include automotive fabrics, tires, and geotextiles (Morris & Wagneur, 2007). Polyamide fiber is mainly used in automotive applications-tire and airbags. Geotextiles, construction applications, and automotive fabrics are made of polypropylene fiber. End uses for acrylic fiber include outdoor fabrics for structural protection and tentage, and roofing for convertible cars (Morris & Wagneur, 2007). In terms of the wipes market, viscose fiber is a driver of innovation. Natural fibers can be used for performance textile applications, yet have lengthy processing times. Generally, the main fiber types for performance textiles include:

- Polyester high tenacity yarn;
- polyamide high tenacity yarn;
- polyolefin fiber
- acrylic staple fiber;
- carbon fiber;
- aramid fiber;
- viscose high tenacity yarn (Morris & Wagneur).

b) Market Dynamics and History of Performance Textiles

Textiles have always been used for applications other than just apparel and home textiles, initially based on natural fibers such as cotton, flax, and jute, and first embracing man-made fibers with the development and commercialization of industrial strength viscose and polyamide (Rigby Associates, 2002). In the 1960's and 1970's the development of man-

made fibers and an international man-made fiber industry, opportunities for innovative and performance textile applications grew. Although, various performance applications were developed, little emphasis was placed on the opportunities and niche markets available for this industry.

During the latter half of the 1980's, traditional textile companies began to understand the benefits associated with competing in the performance textile industry. Performance textiles offered a fresh start to the textile industry, which at least in major industrialized countries, was being battered by low cost imports and stagnant consumer markets (Rigby Associates, 2002).

The early adopters of performance textile technology and fiber technology were the fiber and chemical producers and machinery manufacturers. Downstream supply chain participants continued to drive much of the innovation in today's performance textile markets. Upstream linkages quickly began to understand the potential and competitive advantage offered by the performance textile industry and soon the entire textile community (industry associations, consultants, educational and research organizations) were demanding the shift towards products with value enhancement, performance attributes, and innovative fibers and finishes.

The 1990's has been deemed the age of the performance textiles industry by many leading industry experts and analysts. Rapid growth and expansion into new markets categorized most of the early years of the decade, but many parts of the industry experienced recessionary cycles in the latter half. High research and development costs, lengthy development and acceptance periods, a lack of controlled business development and

alliances, and a vast product mix forced many performance textile companies to restructure their current models.

Additionally, those companies that were growth drivers in the early 1980's, began to withdraw from selected markets and curtail their product variety. A number of major rationalizations have subsequently taken place, with exchanges of product portfolios, and a concentration on a smaller number of manufacturing locations which are more strategically placed to serve emerging markets with differentiated products (Rigby Associates, 2002).

c) Shift in Marketing Strategies

The move from a “push” market to a “pull” market is restructuring the performance textiles industry. Prosperity in the performance textile industry is reliant on cooperation. It is important that manufacturers throughout the processing chain (manufacturers of machinery, fibers, and technical end uses) cooperate to ensure that technological innovations fulfill the customers needs (Morris & Wagneur).

Performance features such as strength, fire retardancy, and temperature resistance are now becoming requirements and are relatively easy to achieve by companies throughout the world. Furthermore, consumers are demanding these products. The major driver of innovation in the growth of technical textiles consumption was technology push; today this is replaced by market pull (Rigby Associates, 2002). This change was confirmed by focus group data, which will be discussed in latter sections.

The focus is now switching to the achievement of secondary product and performance characteristics such as low cost, lightness, recyclability, long life, and ease of replacement (Rigby Associates, 2002). Another factor driving the market is the low rate of innovative

fibers introduced in the market. Companies are now looking to develop innovative fabrics, and find more end uses for products with existing technologies.

The following changes are outlined by Rigby Associates (2002) and are imperative for meeting the needs of the final customer:

- End use customers are increasingly confining their major commercial relationships to their first-tier suppliers, whose job is then to create and organize a supply chain to produce the required cost effective innovation.
- End use customers are dictating increasingly demanding targets for the cost-effectiveness of the products supplied to them. The challenge is then for the supply chain continually to innovate products in terms of both performance and cost.
- The balance of power is moving away from the owners of particular technologies towards those who integrate several technologies to produce the required end products and performance levels.
- In particular, the profits of producers of intermediate performance textile products are in danger of being squeezed between the power of their big suppliers of fibers, polymers, chemicals, and machinery, and the power of ultimate end users and their first tier suppliers.

d) Industry Characteristics

As the performance textile market matures, global competition is increasingly becoming a factor. The following paragraphs will highlight important global regions in the performance textile market.

Europe

European production of performance textiles has increased substantially since 1995 (Morris & Wagneur, 2007). Output has increased in all parts of Europe and Turkey. Table 18 provides production statistics of the European performance textiles sector.

Table 18 *Europe: Production of Technical Textiles, 1995-2012*

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									

Source: Morris, D., & Wagneur, C. (2007). *World Markets for Technical Textiles to 2012*. Worcestershire, UK: International Newsletters LTD.

China

The importance of China as a producer of performance textiles has increased significantly since 2000 (Morris & Wagneur, 2007). The automotive sector is important in terms of the consumption of performance textiles in China. Consumption of technical textiles for automotive applications is forecasted to reach 750,000 tons by 2012 (Morris & Wagneur, 2007).

Additionally, growth rates are associated with most performance applications in China. Table 19 provides statistics on the production of technical textiles by end use from 2002 to 2010.

Table 19 China: Production of Technical textiles 2002-2010

China: Production of Technical textiles 2002-2010		
('000 tons)		
	2002	2010*
Canvas, tarpaulins and tents	270	400
Medical and sanitary applications	230	250
Reinforcement materials	222	300
Fishing nets	220	250
Synthetic leather	218	300
Filtration	200	350
Packaging	150	250
Transport	90	300
Protection and safety	80	120
Rope, cables, and tapes	76	100
Geotextiles	60	100
Agrotextiles	50	100
Felts	50	70
Insulation	44	80
Military	40	50
Architecture and construction	35	130
Sports	30	60
Papermaking clothing	18	30
Total	2083	3240
*Forecasts		

Source: Handbook of Statistics, Association of Synthetic Fiber Industry, Mumbai

Performance textiles provide long-term potential for many United States' (U.S.) textile companies. Specifically, the share held by the performance textile industry will

expand further at the expense of the traditional textile industry (Morris & Wagneur, 2007). In the United States of America, total fiber consumption for performance textiles increased steadily during the 1990's, reaching over 2 million tons (Morris & Wagneur, 2007). In 2000, estimates suggest it accounted for some 30% of end-use fiber consumption in the region and was worth 17 billion dollars (Chang & Kilduff, 2002).

Stabilization of growth is currently occurring in the market (2007), and forecasts indicate that total consumption will fall to 1.8 million tons in 2012. Growth markets will continue in spite of decrease in overall totals, specifically in sectors associated with security, medical, and protection (Morris & Wagneur, 2007). Industrial nonwovens provide additional growth opportunities. Table 20 provides data specific to the growth of technical textiles, by fiber type in the US.

Table 20 USA: Fiber Consumption of Technical Textiles, by Fiber Type, 1995-2012

USA: Fiber Consumption of Technical Textiles, by Fiber Type, 1995-2012									
('000 tons)									
	1995	2000	2001	2002	2003	2004	2005	2008*	2012*
Cellulosic filament yarn	8.3	3.9	2.6	2.2	2	1.2	1.1	1	1
Cellulosic spun yarn	57.3	36.8	378.8	37.8	39.2	45	49.5	52.2	57.2
Synthetic filament yarn	722.6	836.4	782.8	779.8	780.3	804.3	782.3	737	687.5
Synthetic spun yarn	723.5	985.9	896.9	928.7	912.1	962.3	987.8	977.8	953.3
Cotton	157.3	164.9	160.1	157.3	158.3	144	150.6	150.5	142.5
Wool	7.1	5.7	4.5	4	3.5	3.5	2.5	2	2
Total	1676.1	2033.6	1885.7	1909.8	1895.4	1959.8	1973.8	1920.5	1843.5
*Forecasts									

Source: Morris, D., & Wagneur, C. (2007). *World Markets for Technical Textiles to 2012*. Worcestershire, UK: International Newsletters LTD.

In terms of end market applications for the United States, some markets will experience a decline while others will see increases in market demand. For example, consumption of seat belts will decrease as a result of decline of domestic automobile production in addition to the consumption of tapes for zippers as a result of the declining apparel sector (Morris & Wagneur, 2007). Meanwhile, the medical market will experience growth in demand. For medical, surgical, and sanitary applications, consumption of fibers show reasonable growth (Morris & Wagneur, 2007).

Globally, the production of performance textiles will expand rapidly over the following years to 2012 (Morris & Wagneur, 2007). Expansion will occur mainly in developing countries such as Asia. Developing countries will gain market share through lowered manufacturing costs and the increased availability of technology. Specifically, developing countries will focus primarily on technical textiles that can be produced easily and for which there is a large domestic and export oriented market (Morris & Wagneur, 2007). Examples of such products include basic hygiene and medical applications, geotextiles, and shoe fabrics (Morris & Wagneur, 2007).

Growth opportunities exist for North Carolina companies that expand their performance capabilities and products to foreign markets. The new century is presenting players in the technical textiles sector with the challenges and opportunities of globalization and with a market which, although set for excellent growth, is increasingly unforgiving to companies which are unable to unwilling to formulate strategies for success (Payne & Payne, 2002).

As markets expand, innovation is critical in the performance textile sector.

Performance textiles offer many export opportunities since many developing countries need highly technical, niche products, but lack the infrastructure to manufacture these products. While this may be the case now, developed countries must adopt innovation strategies in order to maintain trade leadership in this increasingly competitive sector. In many developing countries, increasing affluence and developments in infrastructure will boost growth in the sector (Morris & Wagneur, 2007).

Performance markets can deter competition from developing countries by focusing on tight specification standards and highly technical products. United States' companies investing in product development are fostering close partnerships with customers and providing new growth markets, with some benefits of competitiveness (at least in the short-term – against global competitors). Regarding competitiveness in terms of quality and standards, compliance is an issue. It is unlikely that imports of all performance textiles into developed economies meet the necessary requirements imposed upon domestic manufacturers (Morris & Wagneur, 2007). Developed countries must increase control over imports in terms of compliance with standards; if not domestic producers will continue to face unfair foreign competition.

The performance textile sector is reliant on technological change and innovation in terms of product and processes. Since the last market report was published (2002), several technological changes have occurred in end uses, processes, and fiber production. These are discussed in detail in the most recent market report; *World Markets for Technical Textiles to 2012* (2007). Summaries of these developments are included below.

The automotive sector has achieved technological advances through the use of viscose with thermostable properties. Viscose fiber has allowed for two important trends to take place in the automotive sector: one is towards the manufacture of tires with higher sidewalls for SUV's; the other is towards the production of run-flat tires, also known as self supporting tires (Morris & Wagneur, 2007).

The protective clothing sector has seen increased demand in terms of uniforms, flak jackets, and bulletproof clothing (Morris & Wagneur, 2007). Aramid fibers are used in the production of protective clothing, thus an increase in aramid fiber production is forecasted. A radical innovation in the apparel sector of performance textiles is the development of "cosmeto-textiles". These are defined as textiles functionalized with cosmetics and are designed for apparel enhanced with moisturizing, slimming, scent, energizing, refreshing, relaxing, and vitalizing properties (Morris & Wagneur, 2007).

While the automotive and protective sectors are experiencing product innovations, process innovations are occurring in terms of heightened environmental legislation. In particular, there has been a shift from chemical bonding to thermal bonding in the manufacture of unspun products such as filling and wadding (Morris & Wagneur, 2007). Hydroentangling processes have also experienced process innovations, thus meeting the demand for lightweight nonwoven products. It is the fastest growing technology in the nonwovens sector.

Radical innovations are occurring in the production of enhanced fibers. Polyester fibers with added value include bicomponent fibers, finer, fibers, blends with aramid, new finishes, and high shrinkage (Morris & Wagneur, 2007). Additionally, fibers have been

developed in order to meet environmental needs. Polyactide fiber is biodegradable and has renewable properties. Polyactide is important to the processing of staple fibers into spun yarns and for nonwovens (Morris & Wagneur, 2007). Also Lyocell fiber is meeting environmental demands in terms of low impact in manufacturing processes. A push towards the use of natural fibers is also timely for environmental needs. Innovations in the applicability of soya fibers and bamboo are occurring in the performance textile market, especially in the medical and apparel sectors.

Innovation and technological change plays an important role in the future growth of the global market for performance textiles (Morris & Wagneur, 2007). Developments in product innovation and machinery technology will be influenced by shifts in market trends (Morris & Wagneur, 2007) and the needs of end customers. Also, large retailers are increasingly pulling performance fabrics through the supply chain. As a result, fabric and fiber requirements are becoming more stringent (Morris & Wagneur, 2007). The development of finer fibers with high strength will continue to drive innovation in terms of fiber production. In the manufacturing sector of performance textiles, innovations will be specific to adding value in the manufacturing process. This includes increasing productivity and improving manufacturing processes with regard to environmental concerns (Morris & Wagneur, 2007).

In response to the changes in the performance textile industry, companies must change and restructure. Developed economies will have to adopt appropriate strategies to maintain importance in the global market for technical textiles (Morris & Wagneur, 2007). Innovative, specialty products must be the foundation for competitive advantage in terms of the developed markets. This will result in the increasing use of specialty fibers, notably

bicomponent products, solution dyed fibers, and micro fiber. While specialty fibers will drive competitive advantage in developed markets, fiber producers must find a balance between the production of commodity products which leads to volume, economies of scale, and lower fixed costs and specialty products.

The following four responses are outlined by Rigby Associates (2002) and are critical for North Carolina companies who wish to achieve competitiveness in this sector.

- Adjust the balance of the business approach away from technology push and towards market pull. Listen to target customers.
- Focus on solving real consumer problems and less on commercializing products those consumers do not need or do not know what to do with. New product opportunities do not always arise out of new technology.
- Utilize good supply chain relationships and develop intellectual property and patents.
- Innovate in areas other than technology. Innovate through supply chain relationships, communications, internal culture, staff recruitment, training, business systems, and environmental concern. (Adapted from Rigby Associates, 2002).

Additional strategies are outlined in *Strategies of Leading International Technical Textiles Companies (2002)*. These strategies are compiled from various case studies of leading technical textile companies. Key strategies include:

- Adding scale and reach to group operations through acquisition and merger.
- Expanding the number of geographical market in which a company sells its products.
- Establishing a manufacturing presence in a number of regions in the world.
- Reducing costs to a minimum. This is of utmost strategic importance in the

nonwovens industry and other important technical textile sectors.

- Maximizing the level of added value in corporate operations.
- Engaging in capital expenditure projects, not only to ensure peak fitness of company facilities but steadily to upgrade plant and equipment to help maintain competitiveness with rivals and to facilitate the perennial process of winning customer orders.
- The strong branding of products.
- Maintaining a robust approach to new product development and introduction, and to identifying and being proactive in the formation of new applications for existing products (Payne & Payne, 2002).

Lastly, relocation and expansion strategies will need to be examined by domestic producers of technical textiles. The following provides criteria for successful overseas investment as outlined in: *World Markets for Technical Textiles to 2012* (2007).

- The domestic market must be large enough and have sufficient disposable income.
- Economic growth must be sufficient to support increases in purchases of consumer and industrial products.
- The infrastructure must be sufficiently developed to support a technology based industry. There should be an adequate supply of power, efficient transportation, and a skilled, trainable labor force.
- The business environment must be conducive to investment and there should be political stability. There should also be minimal trade restrictions, an appropriate legal system, adequate financial services, and a tax schedule that allows for profits to

- be made, retained, and withdrawn if necessary.
- There should be access to raw materials for proposed and future levels of manufacture.
 - The market should offer opportunities for growth.
 - It is important to select optimum technology in terms of process type, product type, and product mix to ensure that the production base is compatible with future long term stable growth.
 - Manufacturers must be aware of legislative requirements regarding environmental and ecological standards. (Morris & Wagneur, 2007).

Step 3: Validation from the North Carolina Textile Complex (Focus Group)

The research sample consisted of a total of 53 participants from 34 North Carolina textile-related companies representing the performance textile complex. Table 21 provides detailed information about the sample, including sector, company identification, location, estimated annual sales, and number of employees.

Table 21 *Phase I Focus Group Sample Selection Information*

Sector	Company	Location	Sales for 2006	Number of Employees
Auxiliary	A	North Carolina	\$2,394,497.00	23
Auxiliary	B	North Carolina	N/A	N/A
Fiber/Yarn	C	North Carolina	\$42,570,000.00	1133
Fiber/Yarn	D	North Carolina	\$38,700,000.00	20
Mill Products	E	North Carolina	\$1,700,000.00	25
Auxiliary	F	North Carolina	\$2,600,000.00	25
Auxiliary	G	North Carolina	N/A	N/A
Mill Products	H	North Carolina	N/A	200
Auxiliary	I	North Carolina	\$68,202,785.00	157
Auxiliary	J	North Carolina	\$68,202,785.00	157
Mill Products	K	North Carolina	\$3,400,000.00	3
Mill Products	L	North Carolina	\$3,400,000.00	3
Fiber/Yarn	M	North Carolina	\$164,667,600.00	1200
Auxiliary	N	North Carolina	N/A	N/A
Auxiliary	O	North Carolina	N/A	N/A
Mill Products	P	North Carolina	N/A	880
Fiber/Yarn	Q	North Carolina	\$24,000,000.00	130
Auxiliary	R	North Carolina	\$0.00	8
Auxiliary	S	North Carolina	\$0.00	10
Mill Products	T	North Carolina	N/A	N/A
Mill Products	U	North Carolina	N/A	2711
Fiber/Yarn	V	North Carolina	N/A	700
Auxiliary	W	North Carolina	N/A	N/A
Auxiliary	X	North Carolina	N/A	3510
Fiber/Yarn	Y	North Carolina	N/A	3510
Fiber/Yarn	Z	North Carolina	N/A	35
Mill Products	A1	North Carolina	\$150,000,000.00	54
Fiber/Yarn	B1	North Carolina	\$11,000,000.00	66
Fiber/Yarn	C1	North Carolina	\$11,000,000.00	66
Fiber/Yarn	D1	North Carolina	\$30,900,000.00	15
Mill Products	E1	North Carolina	\$97,053,460.00	305
Fiber/Yarn	F1	North Carolina	\$43,067,202.00	286
Fiber/Yarn	G1	North Carolina	\$745,324,410.00	2767

Source: Adapted by Nelson (2008) from North Carolina Textile Complex Database

Company Information

Companies represented in the study were from the following sectors: fiber/yarn, mill

products, and auxiliary sectors. Table 22 provides the percentage of respondents from each sector.

Table 22 *Percentage of Respondents/Sample Size by Sector*

Sector	Percentage/n
Auxiliary	36.3%/12
Fiber/Yarn	36.3%/12
Mill Products	27.3%/9

The research sample consists of leading textile and apparel firms in each sector in North Carolina. Both auxiliary and fiber/yarn sectors had the greatest representation in the focus group. The auxiliary sector includes service and association organizations for the textile and apparel industry. The fiber and yarn sector consists of companies that produce synthetic fibers and yarn, natural yarn, and texturized yarn (Parrish, 2005). Mill products supplemented the rest of the sample. Mill producers represent fabric producers of woven, knitted, and nonwoven goods.

Focus Group Results

North Carolina State University's College of Textiles held the inaugural focus group dedicated towards developing a performance textile cluster initiative on June 7, 2007, from 10:00 – 1:30 pm., in the College's Convocation Center. North Carolina is the location of many global companies competing in performance textiles. This inaugural focus group was an opportunity to bring together industry, government, and academic personnel to discuss current and future challenges and opportunities.

A total of 53 participants attended the focus group, representing 34 North Carolina textile-related companies. Participants included industry leaders, consultants, association

representatives, NC State faculty and graduate students, and North Carolina Department of Commerce project managers. See Appendix A6 for complete participant listing.

The morning session began with a Welcome from Dr. Blanton Godfrey, Dean of the College of Textiles. Dr. Nancy Cassill, Principal Investigator, and Holli Nelson, the research study's graduate student, presented a short PowerPoint presentation discussing the research study's objectives, expected results, and definitions related to performance textiles and sub-sector breakouts. The underlying theme of the presentation was to identify the specific needs of the performance textile industry in order to enhance global market competitiveness.

Dr. Trevor Little led participant introductions. Each participant was asked to provide their name, company name, position in company, products or services provided to the industry, and experience level in performance textiles. Representatives of the textile value chain (fiber, yarn, fabric producers, manufacturers, suppliers) were in attendance. The moderator for the focus group was introduced by Dr. Cassill. Once all introductions were completed, focus group discussion began.

Questions focused on four distinct areas vital to understanding the performance textile industry and its sub-sectors: Industry requirements, cluster formation, trade and expertise, and information needed for competitiveness. Performance textiles were defined as textile materials and products manufactured primarily for their technical and performance properties in addition to their aesthetic or decorative characteristics. Key points discussed at the meeting are outlined below.

Industry Requirements and Partnerships

- A lack of established industry standards relating to performance textiles can make it

- difficult to compete, differentiate, and “sell” your product.
- Establishing these standards are critical for competing in this sector and will benefit new product development processes, as well as provide a method for comparing products equally throughout the supply chain.
 - Industry requirements also include social, ethical, and environmental responsibilities. A method for differentiating is to promote and market that US companies meet these social, ethical and environmental responsibilities.
 - Research and new product development are critical to success.
 - With “power” existing further downstream, it is imperative for companies to connect with customers. Close partnerships are needed through the supply chain including the retail sector and end-use consumers as well as with non-retail customers. Future focus groups should also include customers (retail, non-retail organizations).

Competition

- Companies must know the competition, including the competitive environment, competing companies, and market dynamics, including opportunities for product differentiation and niche markets.
- Consumers, as well as supply chain linkages, must understand the balance between quality and price.
- Value is often misunderstood by the consumer. There must be a way to market value and performance attributes to consumers (and customers) in a way that they understand and will be willing to pay more for the product.
- Sub-sectors noted which are more price conscious include apparel and medical

(institutional). Other types of medical applications and very technical applications are not as price sensitive (as these two sub-sectors) and rely heavily on performance attribute identification and education to the customer.

- Competition is not always associated with inter-industry competition, but often is defined by price.

Traditional Textiles vs. Performance Textiles

- Suppliers must stay current with new technology, and in this industry this is not always the case.
- The design to market launch timeline for performance textiles takes ~ 18 months; this means that a longer timeline (than traditional textiles) is needed to realize revenue for performance textiles vs. traditional textiles.
- To compete in the performance textiles global market, companies must compete backwards and forwards. Companies must make sure suppliers are innovative and understand consumer demands, as well as understand the newest performance technologies.
- Vertically integrated companies can often stay ahead of the curve and are reassured that suppliers are using the newest technology offered.
- Consumers are demanding products with performance attributes. Customers are pulling these products through the supply chain. PUSH and PULL strategies are used. One barrier to entry to performance textiles is MENTALITY; this requires companies to approach the performance textile market with diverse strategies (PUSH and PULL).

- Would a performance textile trade show benefit companies in North Carolina? Many participants discussed this idea and believe this is a possibility. It would be more cost effective, less travel time, and could benefit cluster formation and economic development. The hosting site could be NC State College of Textiles, with coordination by the NC Department of Commerce.

Entrance into the Performance Industry

- All types of market entrance methods were discussed and are used to enter this segment. These include: acquisitions, entrance by foreign companies, and expansion.
- Acquisitions are often used by companies wishing to delve into more niche technical areas.
- Foreign companies enter the market by moving locations to North Carolina because of textile history, infrastructure, and market and supplier accessibility.
- Companies can also enter by evolving out of current existing divisions and companies
- Companies need a neutral meeting site that can be used for knowledge and information resources.
- With the planned Summer 2007 launch of the Textile Information Warehouse (a second research project being completed by NC State College of Textiles -- funded by the NC Department of Commerce), performance textile focus group participants agreed to pilot test this electronic information warehouse prior to the launch.
- There is a need for a better understanding of technical applications (geotextiles, agricultural, and other sub-sectors) that comprise the performance textile area.
- A performance textiles seminar would be helpful and many participants would attend.

This seminar could focus on specific technical products (e.g., geotextiles, medical, industrial, other) as well as new product development, market information and market entry.

- Information is needed on how to attract talent with a technical background and expertise. The College is challenged, with the increased enrollment, in preparing the future leaders for this industry, with both product and market expertise.

Next Steps

- Preliminary “next steps” include:
 - Focus groups, segmented by performance application
 - Educational seminars related to specific performance textile topics
 - New product development and innovation, market dynamics, supply chain dynamics, industry standards, environmental and ethical sustainability, and strategic human resource development
 - Promotional efforts, including trade show development.

Step 4: Segmentation of North Carolina Performance Industry Companies into 12 Sub-Sector Applications and Clusters

The following provides an examination of the North Carolina performance textile industry by each of the 12 sub-sectors. With each presentation of the sub-sector, a *definition* of the sub-sector, *overall global growth* of the sub-sector (as identified by previous research), and a *profile of North Carolina’s presence in this sub-sector* (via “dot map”, sub-sector statistics) is provided. Figure 8 provides a visual depiction of the North Carolina performance textile industry.

PERFORMANCE TEXTILE SECTORS



Figure 11 North Carolina Performance Textile Industry

The North Carolina performance textile industry is represented in 76 out of 100 counties. 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”). The performance textile cluster map provides the foundation for strengthening existing clusters and for using the North Carolina transportation and logistic system to build/ strengthen additional clusters throughout the state.

North Carolina has approximately 517 companies operating in the performance textile industry. Of these 517 companies, 148 operate in multiple performance textile sub-sectors in North Carolina. Eleven percent of the companies competing in the performance textile industry in North Carolina are publicly held and 89% percent of the performance textile

companies are privately held. Currently all 12 performance textile sub-sectors exist in North Carolina. Collectively performance clusters provide an estimated \$18,094,043,464 in annual sales. There are approximately 60,000 employees working in the performance textile industry in North Carolina.

In 2007, North Carolina does have an established performance textile industry infrastructure, with viable growth potential for individual companies, the industry, and the State. In addition to companies producing and marketing performance textile products, there are locally based chemical and machinery manufactures, research universities, trade associations, and skilled labor in the State to service this industry.

It is important to note success factors for competing in performance textile industry, as outlined by Chang & Kilduff (2002). Focus group topics and discussions confirm the importance of these factors when competing in the performance textile industry.

- *High levels of investment in product innovation* are needed to develop precise specification products of dependable quality and improved product solutions that could open up new end use segments.
- Investment in the development of *close working relationships with customers* to provide excellent service.

Sub-sector: Agriculture

Definition

The agriculture sub-sector consists of end use products used by the agriculture, horticulture and fishing industries. Products include but are not limited to nets, ropes, twine,

fabrics, and geotextiles. In addition, protective clothing used by farm workers and transport textiles used in tractors, conveyor belts, hoses, filters, and composite reinforcements are included in this sub-sector. The agriculture sub-sector is driven by the benefits offered by performance textiles in terms of improved productivity, reduced chemicals, and environmentally friendly substitutes.

Overall Global Growth (as identified by previous research)

Overall, this sub-sector has only low unit values (based on average), is expected to grow broadly in line with performance textiles overall as new land based applications, often in the form of nonwovens, offset a general downturn in fishing based end uses such as nets and lines (Rigby Associates, 2002, p. 2.9).

PERFORMANCE TEXTILE SECTORS

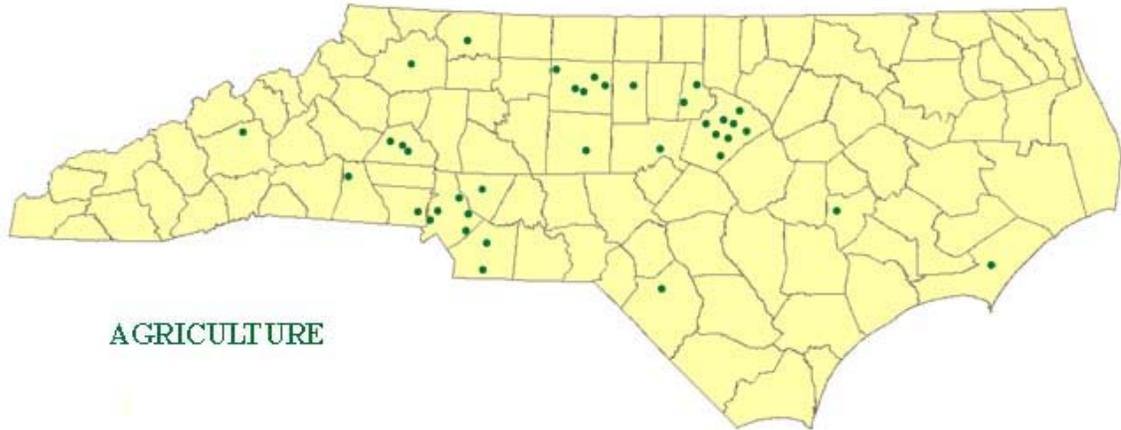


Figure 12 North Carolina Companies Competing in the Agriculture Sub-sector

Number of companies: 35

Number of counties: 17

Cluster configuration: Guilford, Mecklenburg, Wake

Sales \$ (estimated) : \$229,012,542

Employees: 1, 052

Products (sample): Fish and shrimp nets, Elastic for netting, Fiber Mulch, Cellulose Mulch

Sample companies: Performance Fibers, Precision Fibers/Eco Fibers Inc, Profile Products LLC

The agriculture sub-sector in North Carolina has one of the lowest numbers of companies competing in the agriculture sector when compared to the other performance sub-sectors. Additionally, the sales estimates for the agriculture sub-sector are the second lowest of all other sectors. The lack of companies reported and sales data estimated in the agriculture sub-sector compared to other North Carolina performance sub-sector rankings is most likely due to underreporting of various agriculture product applications by companies. Additionally agricultural applications can also be used in geo-textile applications making it hard for companies to differentiate products and market to the appropriate end user.

Growth opportunities in agriculture exist in North Carolina because of the introduction of more modern materials in the sector. Additionally agriculture compliments the geotextiles sub-sector, which is vital to today's global companies focused on sustainability and environmental protection. NC State researchers recommend market and product knowledge and training for North Carolina companies competing or entering this sub-sector.

Sub-sector: Construction

Definition

Performance textiles are most often used in the construction of buildings, dams, bridges, tunnels, and roads. Tents, marquees, awnings, and the construction of semi- permanent structures such as sports stadiums, exhibition centers, and other modern buildings use performance textiles. With an increase in natural disasters and terrorism threats, in addition to an increase in commercial events, a growing need for performance textiles in this sub-sector has been identified. Supporting industries and professions impacted by this sub-sector include development, testing, and acceptance organizations, architecture, construction

engineers, contractors, and regulatory bodies.

Overall Global Growth (as identified by previous research)

The potential uses for performance textiles in the construction sub-sector are almost limitless. This is one of the fastest growing sectors as performance textile products replace more traditional building materials in the form of both hidden components and end products (Rigby Associates, 2002). The difficulty associated with this sub-sector includes the strongly cyclical nature of the construction industry and the unevenness of construction projects, the long testing and acceptance procedures, and communication between supporting industries (Horrock & Anand, 2000).

PERFORMANCE TEXTILE SECTORS

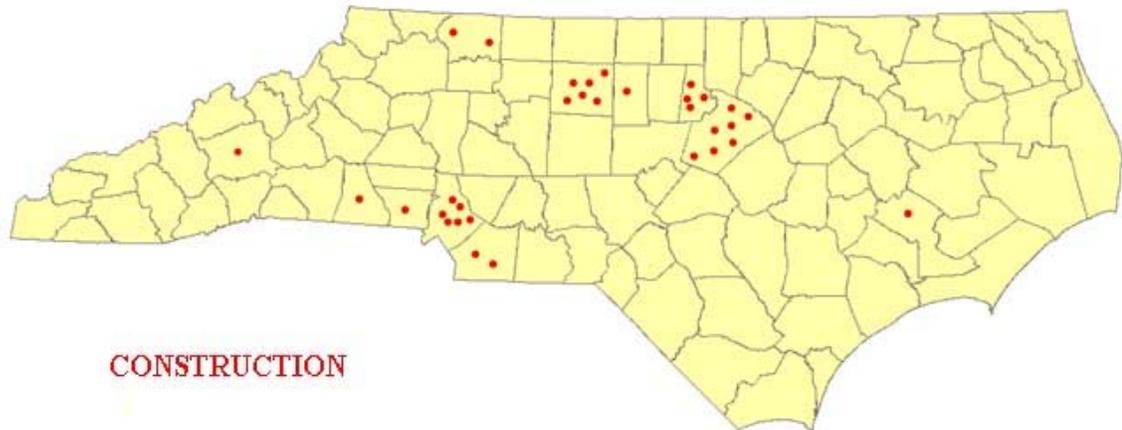


Figure 13 North Carolina Companies Competing in the Construction Sub-sector

Number of companies: 32

Number of counties: 11

Cluster configuration: Durham, Guilford, Mecklenburg, Wake

Sales \$ (estimated) : \$726,213,045

Employees: 1,324

Products (sample): Glass, carbon, cellulose, and aramid fibers for use in construction and composite markets, insulation for home builders

Sample companies: BGF Industries, Inc, US Green Fiber, Weyerhaeuser Paper Company

The construction sub-sector has a reportedly low number of companies competing in North Carolina. In terms of estimated sales, the North Carolina construction sub-sector ranks ninth among other North Carolina performance textile sub-sectors. The discrepancy in rankings can be attributed to the expense of construction textiles. These materials are often developed using expensive fibers and materials, thus increasing costs throughout the supply chain to develop such products.

Additionally, construction requirements and standards differ from project to project, making it difficult to become an industry leader in the construction sub-sector. NC State researchers believe construction textiles are vital due to their limitless application, but recommend North Carolina companies pair specialization of construction textiles with geotextiles or agricultural textiles. NC State researchers recommend market and product knowledge and training for North Carolina companies competing or entering this sub-sector.

Sub-sector: Apparel

Definition

The apparel sub-sector includes fiber, yarns, and textiles used as technical components in the manufacture of clothing such as sewing threads, interlinings, waddings, and insulation. This sub-sector does not include the main or outer linings of fabrics or garments, nor does it include protective clothing, which is contained in a separate sub-sector (Horrocks & Anand, 2000).

Note: *Apparel products are also included in the sport, medical, and protection sub-sectors.*

Overall Global Growth (as identified by previous research)

The performance apparel sub-sector parallels the pattern of low market growth associated with traditional textiles used in commodity-based apparel. Only slow growth is forecasted for clothing components since there is limited further opportunity for increased textile usage per garment and demand for garments, especially from developed countries (Rigby Associates, 2002). Additionally, the relocation of garment manufacturing to low cost countries hinders growth opportunities for domestic textile companies unable to compete with low labor costs.

PERFORMANCE TEXTILE SECTORS

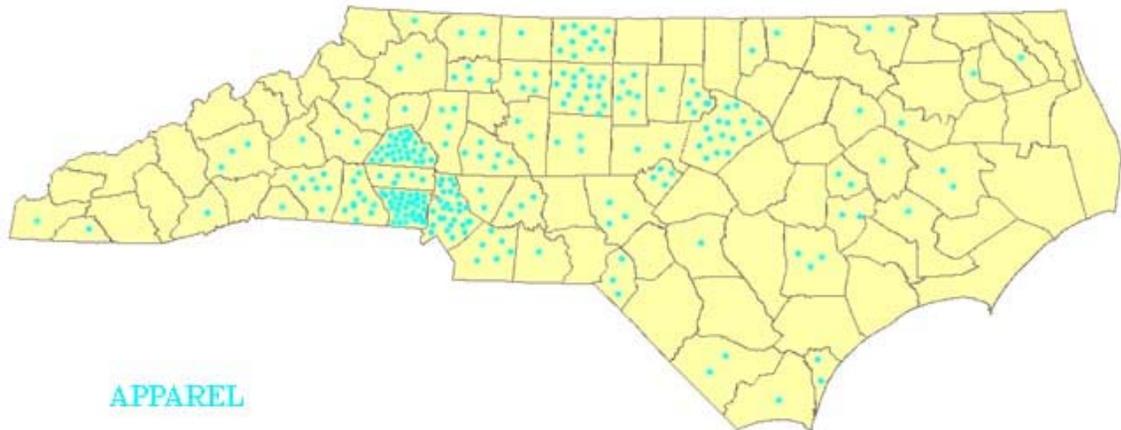


Figure 14 North Carolina Companies Competing in the Apparel Sub-sector

Number of companies:73

Number of counties: 22

Cluster configuration: Guilford, Mecklenburg, Catawba, Gaston, Wake

Sales \$ (estimated): \$2,368,699,845

Employees: 6,251

Products (sample): Sportswear, outerwear, performance apparel, athletic socks

Sample companies: HanesBrands, Swift Galey, Longworth Industries

The apparel sub-sector in North Carolina ranks third in terms of sales estimates and fifth in number of companies competing when compared to all North Carolina performance textile sub-sectors. Using definitions developed by previous research the apparel sub-sector only

encompasses companies that produce fiber, yarn, and textiles for performance apparel. Because of this limitation, the representation of performance apparel companies could be skewed. Performance apparel companies providing products in medical apparel, protection apparel, and sportswear are not included in the apparel sub-sector.

Opportunities for North Carolina companies in the apparel sector are limited. Although the products possess value-added characteristics, low cost replicates can often be produced offshore. North Carolina companies providing niche performance apparel products (ex. temperature change materials) are positioned to experience the highest growth opportunities. NC State researchers recommend growth and expansion from traditional apparel applications to niche performance apparel products.

Sub-sector: Geotextiles

Definition

This sector is comprised of geosynthetics, geotextiles, geogrids, and geomembranes used in civil engineering. End use products are found in rail and road embankments, reservoirs, river and coastal protection, and landscaping (Woon, 2002). Nonwovens and composite fabrics are used to manufacture most of the materials used in these end use products. Geotextiles are fundamentally green and environmentally friendly.

Note: *Geotextiles are also included in the Agriculture sub-sector.*

Overall Global Growth (as identified by previous research)

Geotextiles represents the sector with the highest growth rate (except for environmental) as reported in 2002 (Rigby Associates, 2002, pg 2.9). The economic and environmental advantage of using performance textiles to reinforce, stabilize, separate, drain,

and filter are already well proven (Horrocks & Anand, 2000). Given the characteristics of the market, no two installations are the same and each can use vast quantities of fabric.

PERFORMANCE TEXTILE SECTORS

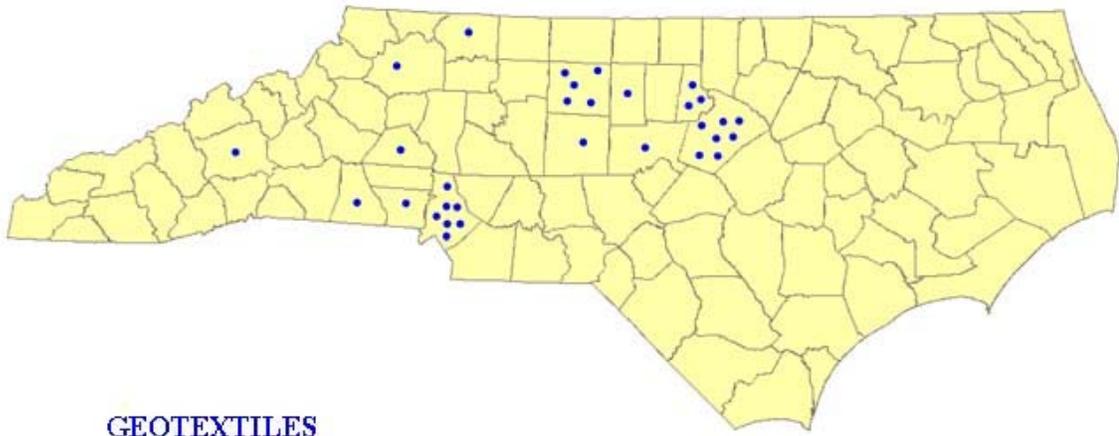


Figure 15 North Carolina Companies Competing in the Geotextiles Sub-sector

Number of companies: 40

Number of counties: 18

Cluster configuration: Durham, Mecklenburg, Wake, Guilford,

Sales \$ (estimated): \$227,572,542

Employees: 1111

Products (sample): Polypropylene geomembranes, geosynthetic products used for soil erosion

Sample companies: JPS Elastomerics Carolina Plant, GSI General Materials, Huesker Inc.

Geotextiles ranks the lowest for sales estimates among the other sub sectors in North Carolina and includes a relatively low number of companies in comparison to other North Carolina performance industry sub-sectors.. Geotextiles overlap agricultural, industrial, and environmental sub-sectors which is a possible factor for underreporting.

Although, North Carolina is currently not strong in the geotextiles subsector, opportunities for the sub-sector do exist. Economically, geotextiles provide a less expensive substitution for traditional geosynthetics materials. Additionally, with increased awareness and protection of environmental impact, North Carolina companies specializing in geotextiles will be demanded. NC State researchers recommend market and product knowledge and training for North Carolina companies competing or entering this sub-sector.

Sub-sector: Home Furnishings

Definition

Home furnishings encompass household textiles, furnishing, upholstered furniture, bedding, cushions, sleeping bags, and furniture backings. Current consumer trends in creating outdoor lifestyle settings are a large driver of this sector. Additionally, fiber substitution also drives the industry due to increased concern over the fire and health hazards posed by traditional materials (Horrocks & Anand, 2000).

Overall Global Growth (as identified by previous research)

Growth rates in this sector are the lowest of all, reflecting generally low forecasts for final demand for household goods, the limited opportunities for further textile penetrations, and a steady switch from woven to lighter and lower priced nonwoven components (Rigby Associates, 2002).

PERFORMANCE TEXTILE SECTORS

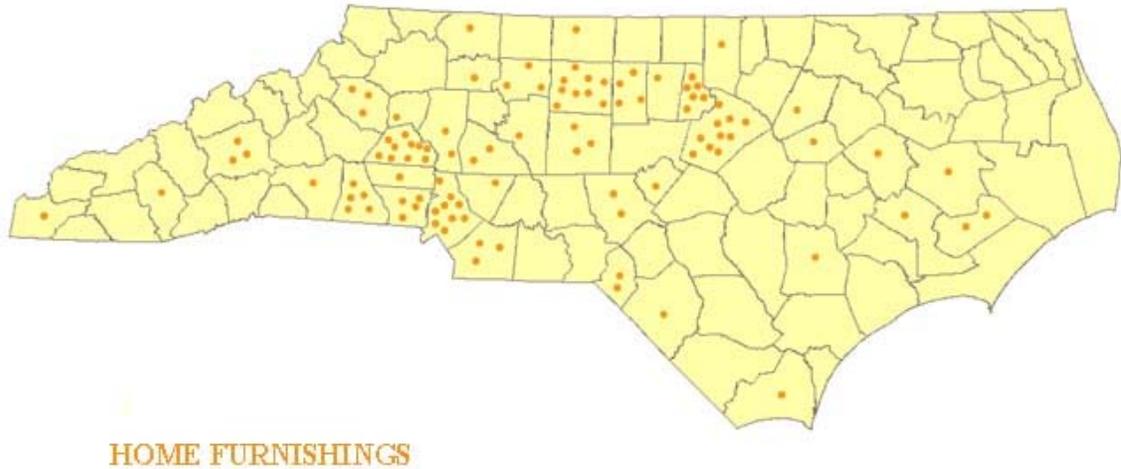


Figure 16 Carolina Companies Competing in the Home Furnishings Sub-sector

Number of companies: 90

Number of counties: 28

Cluster configuration: Wake, Mecklenburg, Guilford, Catawba

Sales \$ (estimated): \$1,123,668,992

Employees: 4,520

Products (sample): Outdoor cushions/fabric, umbrellas, patio furniture, resins for foam used in furniture

Sample companies: Glen Raven, Shuford Mills, Carpenter Company, Nano-tex Inc.

The home furnishings sub-sector in North Carolina ranks fourth in the number of companies participating and seventh in the number of sales dollars among North Carolina performance industry sub-sectors. Traditionally, many North Carolina companies have specialized in home furnishings and this trend is evident in the data reported. Although growth forecasts are low, NC State researchers recommend North Carolina companies to continue to develop home furnishings with performance attributes. North Carolina companies must develop products that meet consumer trends (outdoor furniture) and revised regulations (fire retardency, health requirements).

Sub-sector: Industrial

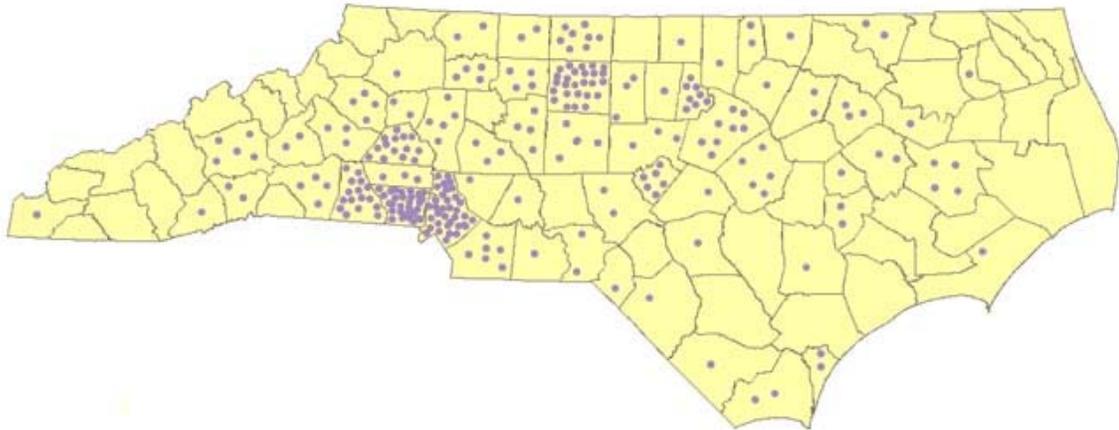
Definition

The industrial sub-sector is extremely diverse. The most precise definitions define industrial textiles as those used directly in industrial processes, or incorporated into industrial products such as filters, conveyor belts, and abrasive belts, as well as reinforcements for printed circuit boards, seals and gaskets, and other industrial equipment (Horrocks & Anand, 2000). Nonwovens, technical fibers, and performance textiles each have a place in this market.

Overall Global Growth (as identified by previous research)

Growth rates for this sub-sector remain above average as further opportunities exist to introduce textile products into industrial processes (Rigby Associates, 2002). It is one of the largest market sectors and a moderately strong growth area (Woon, 2002). Additionally, this sector represents a universal market with universally established regulations and requirements and global leaders are quickly emerging (Woon, 2002).

PERFORMANCE TEXTILE SECTORS



INDUSTRIAL

Figure 17 North Carolina Companies Competing in the Industrial Sub-sector

Number of companies: 273

Number of counties: 52

Cluster configuration: Wake, Mecklenburg, Guilford, and Catawba

Sales \$ (estimated): \$7,887,113,398

Employees: 29,097

Products (sample): Filters, testing equipment and controls, dust cloths, wipes, cordage, and rope

Sample companies: ALSCO/Servitex Inc, Purolator Industrial, Commercial and Residential Air Filtration, Wix Filtration Products, Freudenberg Nonwovens

The industrial sub-sector ranks highest in sales estimates and the number of companies participating when compared to all other North Carolina performance industry sub-sectors. The diversity of this sub-sector and its applications in various end markets can be linked to the discrepancy in reported estimates (sales, companies, employees) when compared to other sub-sectors.

Opportunities for North Carolina exist in this sub-sector. NC State researchers recommend that North Carolina companies narrowly define and differentiate their product offerings in this diverse sub-sector. Furthermore, NC State researchers recommend market and product knowledge and training for North Carolina companies competing or entering this sub-sector.

Sub-sector: Medical

Definition

The medical sub-sector is separated in primarily two markets: hygiene and medical. *Hygiene applications* include wipes, baby diapers, sanitary and incontinence products. These applications are generally commodity based and compete on low cost. Additionally this market is relatively mature and currently an emphasis has been placed on developing products, which present an added value. These products are not considered environmentally friendly and companies competing in this sector experience intensified pressure to develop products that are biodegradable and environmentally neutral. Nonwovens dominate these applications, which account for over 23% of all nonwoven usage, the largest proportion of any of the 12 markets for performance textiles (Horrocks & Anand, 2000).

Medical applications are highly innovative and specialized. These products include dressings, sterilization packs, sutures, and orthopedic products. Extremely sophisticated applications include artificial ligaments, veins, arteries, skin replacements, and hollow fibers. Surgical gowns and bedding also comprise this sub-sector, but often compete in low cost arenas and are influenced by institutional regulations and budget constraints.

Overall Global Growth (as identified by previous research)

The high growth rates associated with this sector are limited to medical applications that are highly specialized. Growth rates in specialized medical applications are extremely high and offer opportunities similar to those seen in construction applications. Performance textile materials also offer value added substitutions to (non-performance) materials offered in the past. Unfortunately, product development lead times are lengthy and the widespread introduction of life critical products takes time and capital.

PERFORMANCE TEXTILE SECTORS

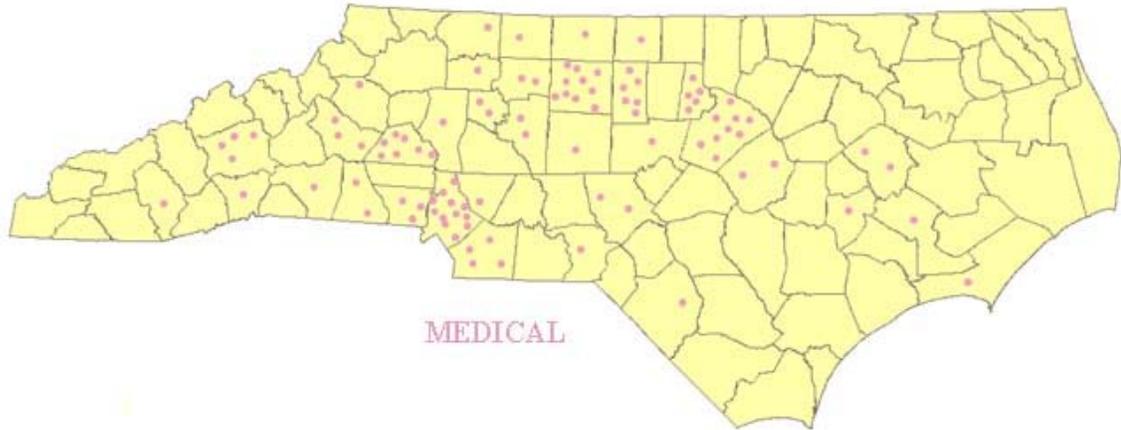


Figure 18 North Carolina Companies Competing in the Medical Sub-sector

Number of companies: 92

Number of counties: 30

Cluster configuration: Wake, Mecklenburg, Guilford, and Catawba

Sales \$ (estimated): \$1,513,621,608

Employees: 6,117

Products (sample): Clean room products, Antibacterial/antimicrobial finishes, wipes, diapers, incontinence products, medical hosiery

Sample companies: Kimberly-Clark Corporation, PGI Nonwovens, Stockhausen Inc.

The medical sub-sector in North Carolina ranks second in the number of companies competing and fifth in sales dollar estimates when compared to the eleven other North Carolina performance industry sub-sectors. Although, opportunities in the sub-sector exist, these opportunities are often dependent upon the development of highly, specialized medical products. Many of the North Carolina companies producing products for the medical sub-sector, produce products that are institutionally based. NC State researchers recommend for North Carolina companies competing in the medical sub-sector to develop products with advanced specialization.

Sub-sector: Transportation

Definition

Transportation applications include cars, buses, trains, ships, and aerospace with products representing *interior* (carpeting, safety belts, air bags , seating), *exterior* (tires, belts, hose reinforcements), and *infrastructure* (composite reinforcements) products.

Overall Global Growth (as identified by previous research)

In 2002, Rigby & Associates report that the transportation sub-sector is the second largest market sector in terms of volume in North America yet represents a very mature market with low growth opportunities (pg. 2.9). However, growth rates in this sub-sector should be interpreted with caution due to the very mature nature of this market. Additionally, recessionary cycles in automotive markets, as well as in military and civil aerospace applications have dealt with severe blows and only those companies with the long term commitment and strength to survive are likely to benefit from the better times that the market periodically enjoys (Horrocks & Anand, 2000).

PERFORMANCE TEXTILE SECTORS

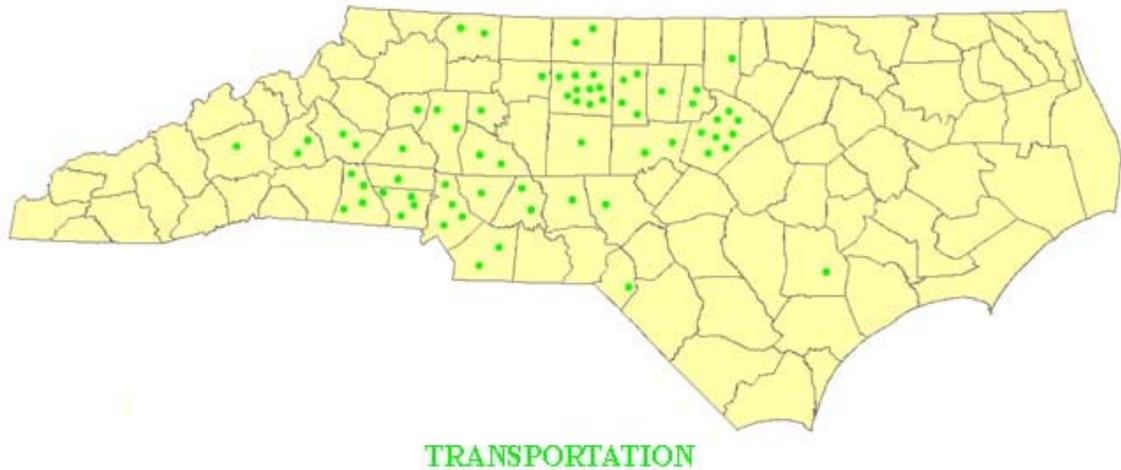


Figure 19 North Carolina Companies Competing in the Transportation Sub-sector

Number of companies: 69

Number of counties: 28

Cluster configuration: Guilford, Wake, Mecklenburg, and Alamance

Sales \$ (estimated): \$3,367,312,345

Employees: 7,482

Products (sample): Specialty tapes used in automotive industry, automotive seats, headliners, airplane seat covers, composite fibers, and nonwovens

Sample companies: Kidde Safety-Headquarters, Guilford, Viscotec Automotive Products, Flint Hill Textiles

The transportation sub-sector in North Carolina ranks sixth in the number of companies competing and second in the amount of estimated sales dollars when compared to all North Carolina performance industry sub-sectors. Although, forecasted global growth rates are low, NC State researchers believe the upward trend of automobile ownership throughout the world will lead to an increased demand of automotive textiles. Recommendations for this sub-sector include increased research and development. Additionally, NC State researchers recommend market and product knowledge and training for North Carolina companies competing or entering this sub-sector.

Sub-sector: Environmental

Definition

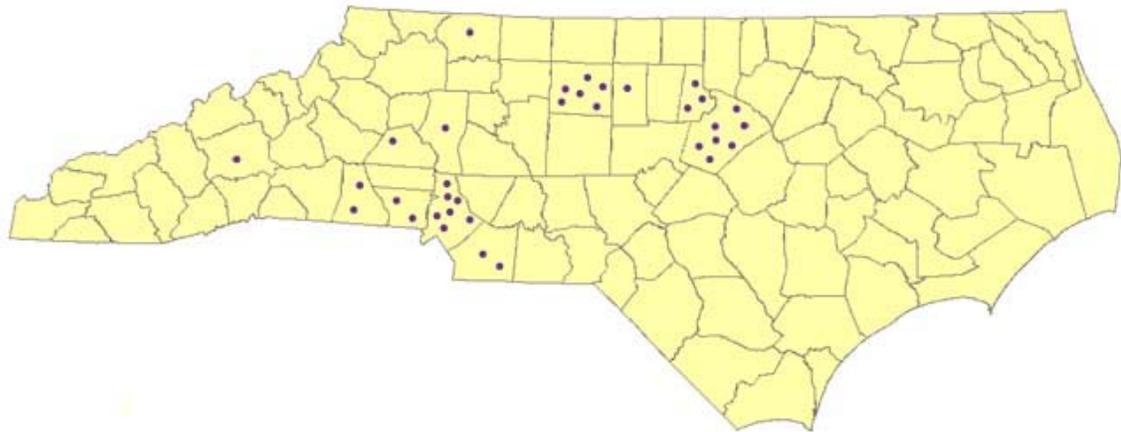
The environmental sub-sector is the least defined sub-sector and overlaps with many existing sectors, yet the growth rate forecasted for this sub-sector is highest of all (as reported by Horrocks & Anand, 2000). The environmental sub-sector provides protection for the environment and ecological homes. Overlaps include industrial textiles (filtration, media), geotextiles (erosion protection and sealing of toxic waste), and agricultural textiles (minimizing water loss from the land and reducing the need for use of herbicides by providing mulch to plants) (Horrocks & Anad 2000).

Note: Several focus group participants indicated that this sub-sector is better represented in all applications and the need for its individual breakout is unnecessary. This is in agreement with the fact that performance textiles can contribute toward environmental protection in almost all applications. For example, performance textiles provide environmental protection by reducing weight in transport, and construction, and thereby saving materials and energy. Improved recycleability is becoming an important issue not only for packaging, but also for products such as cars (Horrocks & Anand, 2000).

Overall Global Growth

Growth rates for this sector are not included due to the overlap among other sub-sectors. Environmental growth rates are highest of all sub-sectors and applications should be implemented throughout all sub-sector markets.

PERFORMANCE TEXTILE SECTORS



ENVIRONMENTAL

Figure 20 North Carolina Companies Competing in the Environmental Sub-sector

Number of companies: 36

Number of counties: 12

Cluster configuration: Guilford, Mecklenburg, Wake

Sales \$ (estimated): \$346,993,650

Employees: 1293

Products (sample): Framework for recycling programs, Biological waste treatment, geotextiles, recycled synthetic fibers

Sample companies: KAO Specialties America LLC, Webtec Inc, Modern Densifying, Inc

The environmental sub-sector ranks ninth in terms of companies competing in North Carolina and tenth in terms of estimated sales dollars when compared to the North Carolina performance industry sub-sectors. Discrepancies in reporting statistics relevant to the environmental sub-sector include overlaps throughout the performance industry. As discussed in focus group conversations, essentially the environmental sub-sector is a component of all sub-sectors. NC State researchers recommend for all North Carolina companies to incorporate environmentally sustainable practices in production and daily business dynamics.

Sub-sector: Packaging

Definition

An increased interest in the environment, coupled with concern over the ease of disposal, ability to recycled, and waste of packaging materials is a powerful growth driver for the packaging sub-sector. Packaging includes performance textiles used for the manufacturing of bags and sacks using woven polypropylene fiber. An important segment is FIBCs (flexible intermediate bulk containers), which are used to handle materials such as powdered, and granular materials ranging from fertilizer, sand, cement, sugar, and flour (Horrocks & Anand, 2000).

The food industry is also a major driver of the packaging sub-sector. Nonwoven materials and knitted structures are used in developing various wrappings for the packaged foods industry. Meats, vegetables, fruits, coffee, and tea are supplied in some type of packaging material. An additional component of the packaging sub-sector includes textile reinforcement for tapes and envelopes.

Overall Global Growth (as identified by previous research)

According to world market forecasts, the packaging sub-sector is the largest in tonnage terms, but its unit values are low and it ranks as one of the smallest in value terms. (Rigby Associates, 2002). Product segments are mature in this sector while new product developments are in infantile stages.

PERFORMANCE TEXTILE SECTORS



Figure 21 North Carolina Companies Competing in the Packaging Sub-sector

Number of companies: 60

Number of counties: 25

Cluster configuration: Guilford, Wake, Mecklenburg

Sales \$ (estimated): \$749,670,067

Employees: 3621

Products (sample): Absorbent paper, paperboard cartons, paper tubes, packaging supplies

Sample companies: Mebane Packaging Group, Weyerhaeuser Paper Company, Sonoco Products-Industrial Division

The packaging sub-sector ranks seventh and eighth in terms of the number of companies competing and estimated sales, respectively when compared to the North Carolina performance industry sub-sectors. Increased environmental concerns are a growth driver for this sub-sector. Recommendations for this sub-sector include developing packaging products, which meet environmental regulations. NC State researchers recommend market and product knowledge and training for North Carolina companies competing or entering this sub-sector.

Sub-sector: Sport

Definition

An increased interest and heightened consumer demand for performance apparel has set the foundation for a market comprised of high performance fibers and specialty garment finishes. The light weight and safety features of performance textile products have become important in this sub-sector and allow for substitution of traditional (non-performance) textile materials.

Overall Global Growth (as identified by previous research)

The growth rate for the sport sub-sector is relatively low due to the mature nature of this market but it represents lucrative opportunities considering the use of expensive fibers and coatings. Additionally, the need for diverse complimentary sport products such as artificial turf, carbon fiber composites used in tennis racquets, fishing rods, golf clubs, and cycle frames makes this sub-sector an attractive and growing market.

TECHNICAL TEXTILE SECTORS



Figure 22 North Carolina Companies Competing in the Sport Sub-sector

Number of companies: 69

Number of counties: 27

Cluster configuration: Guilford, Wake, Mecklenburg, Alamance, Union

Sales \$ (estimated): \$1,390,519,811

Employees: 4,341

Products (sample): Antibacterial/antifungal finishes, performance apparel, uniforms, parachutes, marine products (boating supplies)

Sample companies: Contempora Fabrics, Neuville Industries, HanesBrands, Austin Canvas & Awning, Canvastic, Inc.

The sporting sub-sector in North Carolina ranks sixth in terms of companies represented and in terms of sales dollars estimated in comparison to all other North Carolina performance sub-sectors. Growth opportunities exist for North Carolina companies in this sub-sector. Performance materials are often expensive to produce which in turn increases garment cost. Performance sports apparel is not cost competitive and often commands a premium in the marketplace. This sub-sector provides opportunities for traditional textile companies to grow and expand.

Note: Because of North Carolina's varied geography, enthusiasm for sports and growing recreational economy, this sub-sector could be quite attractive for a local textile cluster.

Protection Sub-sector

Definition

Protective products and end markets (see Table 6) provide safety against cuts, abrasion, ballistic and other forms of impact, fire and heat, hazardous materials, electricity, weather, cold, and poor visibility (Chang & Kilduff, 2002). Although this market is quite small, the products offer value enhancement. Thus, they are generally of high unit values. Furthermore, due to terrorism, health, and safety issues, protective textiles could become an increasingly attractive market segment.

Military textiles, an important component of the protection sub-sector, are also a very opportunistic area. This sub-sector has a large end use market that encompasses both high and low value technical products. It includes uniforms, medical products, and composites used in military equipment, temporary buildings, camouflage fabric, netting and tentage. The military sector also requires constant technical innovation and research and development.

Overall Global Growth (as identified by previous research)

The protective sub-sector is marginally the smallest application area in volume terms, but has high unit values (Rigby Associates, 2002). Additionally supporting industries such as testing, regulatory bodies, government agencies, and pharmaceutical companies are all critical users of products offered by this sector. Newly industrialized countries in Asia provide the highest growth opportunities for this sector.

PERFORMANCE TEXTILE SECTORS



Figure 23 North Carolina Companies Competing in the Protection Sub-sector

Number of companies: 91

Number of counties: 33

Cluster configuration: Guilford, Wake, Mecklenburg, Buncombe

Sales \$ (estimated): \$1,607,474,400

Employees: 4,744

Products (sample): Military and law enforcement uniforms, protective apparel, work gloves, tents, canvas awnings, protective jumpsuits for firefighters

Sample companies: Paraclete Armor & Equipment, Bob Barker Co Inc, Wall Industries Inc, Rope Division, Suits USA, Mills Manufacturing Corp

The protection sub-sector ranks fourth in sales estimates and third in the number of companies competing among all other sub-sectors in North Carolina. This report is indicative of the military presence and influence in the state. The protection sub-sector provides many growth opportunities for North Carolina companies.

Note: As North Carolina has a large military contingent, proximity to the customer can lead to innovation, enhance research and development and potentially provide a niche for a local in-state cluster.

Table 23 Comparison of North Carolina Performance Textile Sub-Sectors

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

Steps 5-6: Identification of sub-sectors with the most opportunity for North Carolina and Validate Opportunistic Sub-Sectors

Average weights for qualitative and quantitative data were combined to determine the top five sub-sectors for further identification and validation in Phase II. Tables 24 and 25 identify sub-sectors with the most growth opportunity for North Carolina.

Table 24 *Sub Sector Selection Averages (Quantitative and Qualitative)*

Sub-Sector Selection	Quantitative Average	Qualitative Average	Total
Sub-sector			
Industrial	4.4	2.25	6.65
Transportation	4.2	1.325	5.525
Apparel	3.6	1.3	4.9
Protection	3	2.175	5.175
Medical	3	2.2	5.2
Sport	3	1.5	4.5
Home Furnishings	2.6	1	3.6
Packaging	2.2	1.7	3.9
Construction	2.8	2.425	5.225
Environmental	1.4	2.275	3.675
Agriculture	1.4	1.6	3
Geotextiles	1.4	2.775	4.175

Table 25 *Sub-Sector Rank*

Sub-sector	Total	Rank
Industrial	6.65	1
Transportation	5.525	2
Construction	5.225	3
Medical	5.2	4
Protection	5.175	5
Apparel	4.9	6
Sport	4.5	7
Geotextiles	4.175	8
Packaging	3.9	9
Environmental	3.675	10
Home Furnishings	3.6	11
Agriculture	3	12

NC State researchers validated the criteria for sub-sector sample selection and refined the listing to:

- Industrial

- Construction
- Medical
- Protection (Military)

Cluster maps for each opportunistic sub-sector were refined in order to validate geographic cluster structure and serve as a basis for focus group topic development. The update maps are shown in the figures below.

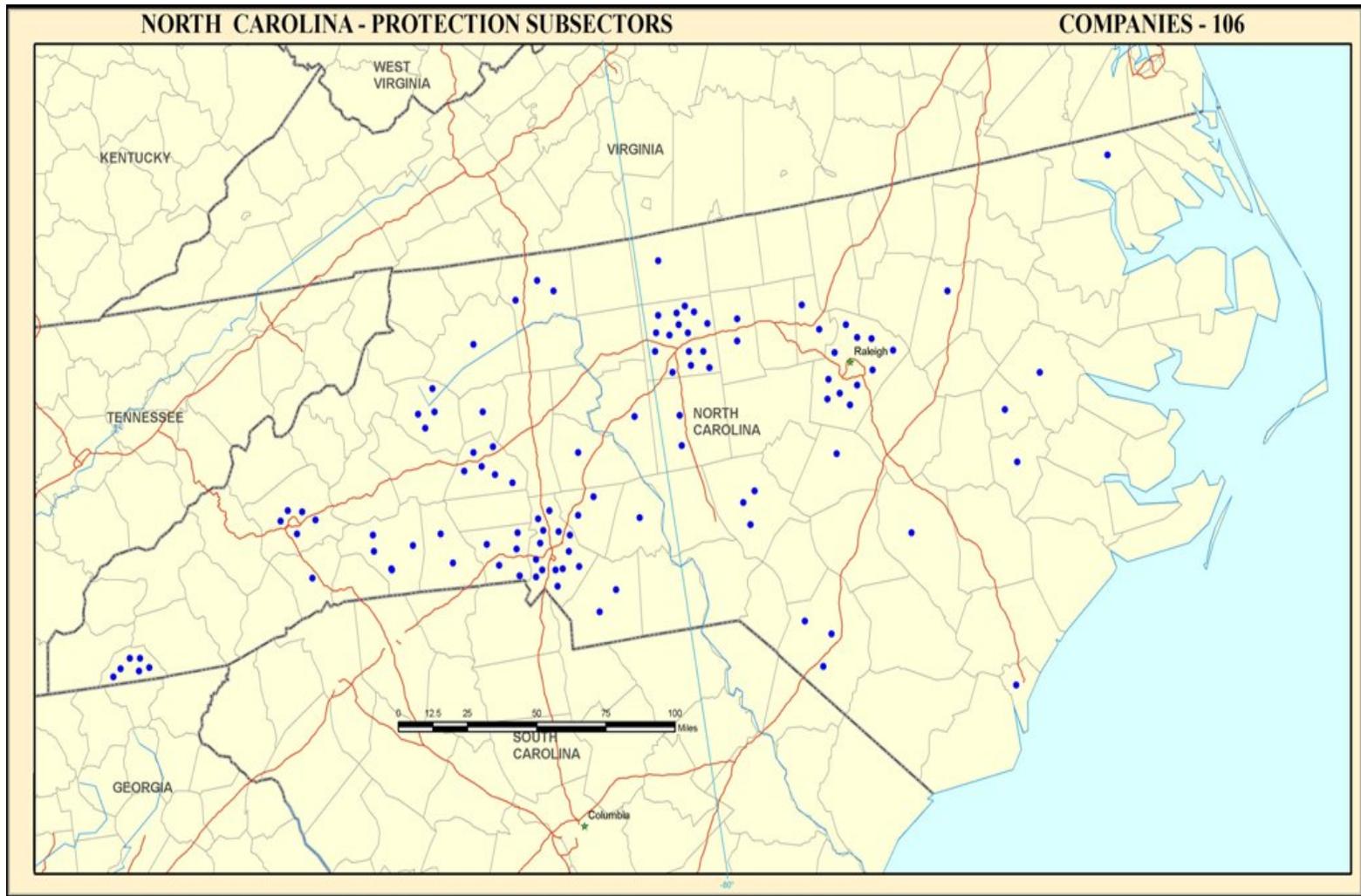


Figure 24 Protection Cluster

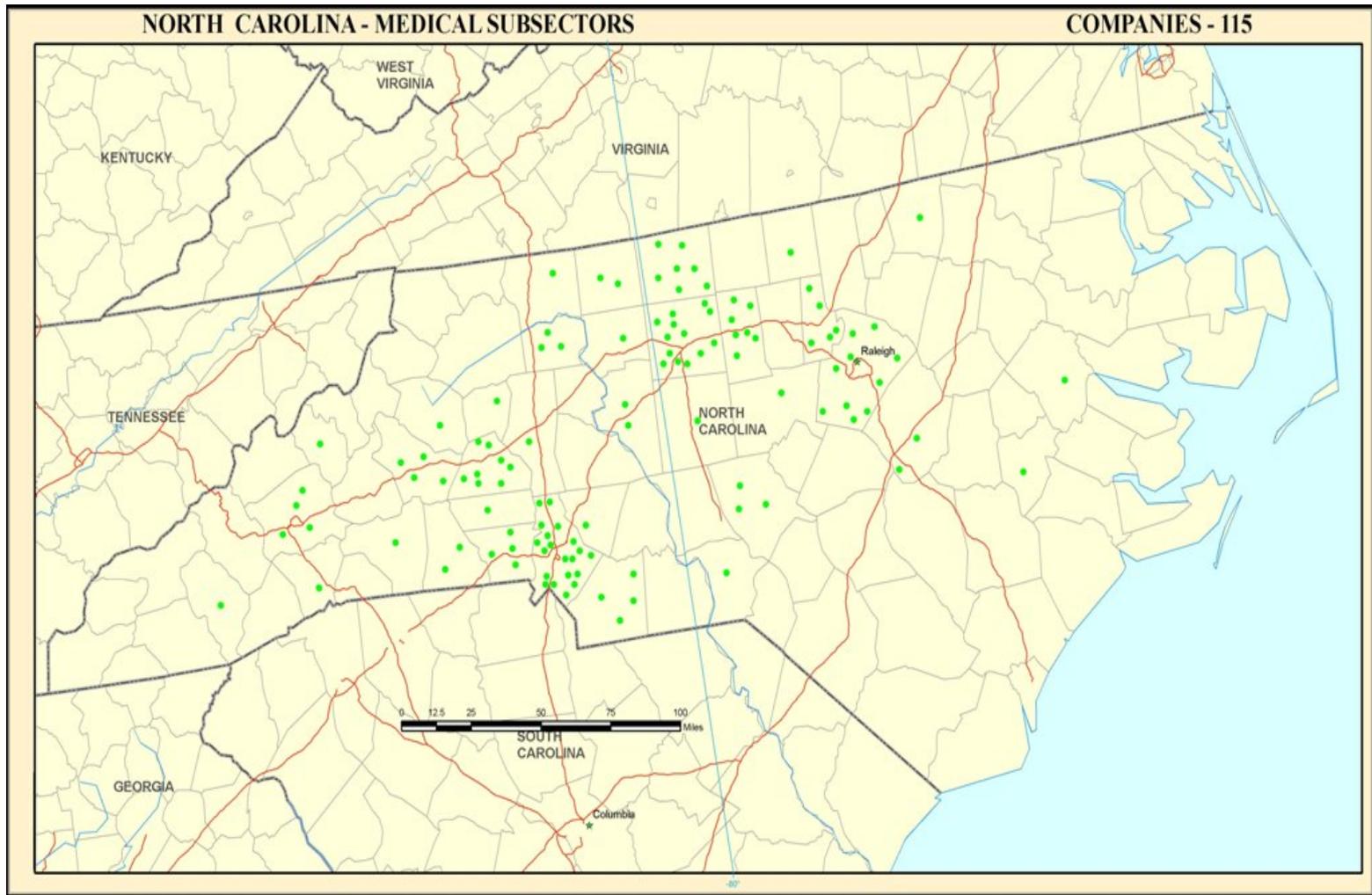


Figure 25 Medical Cluster

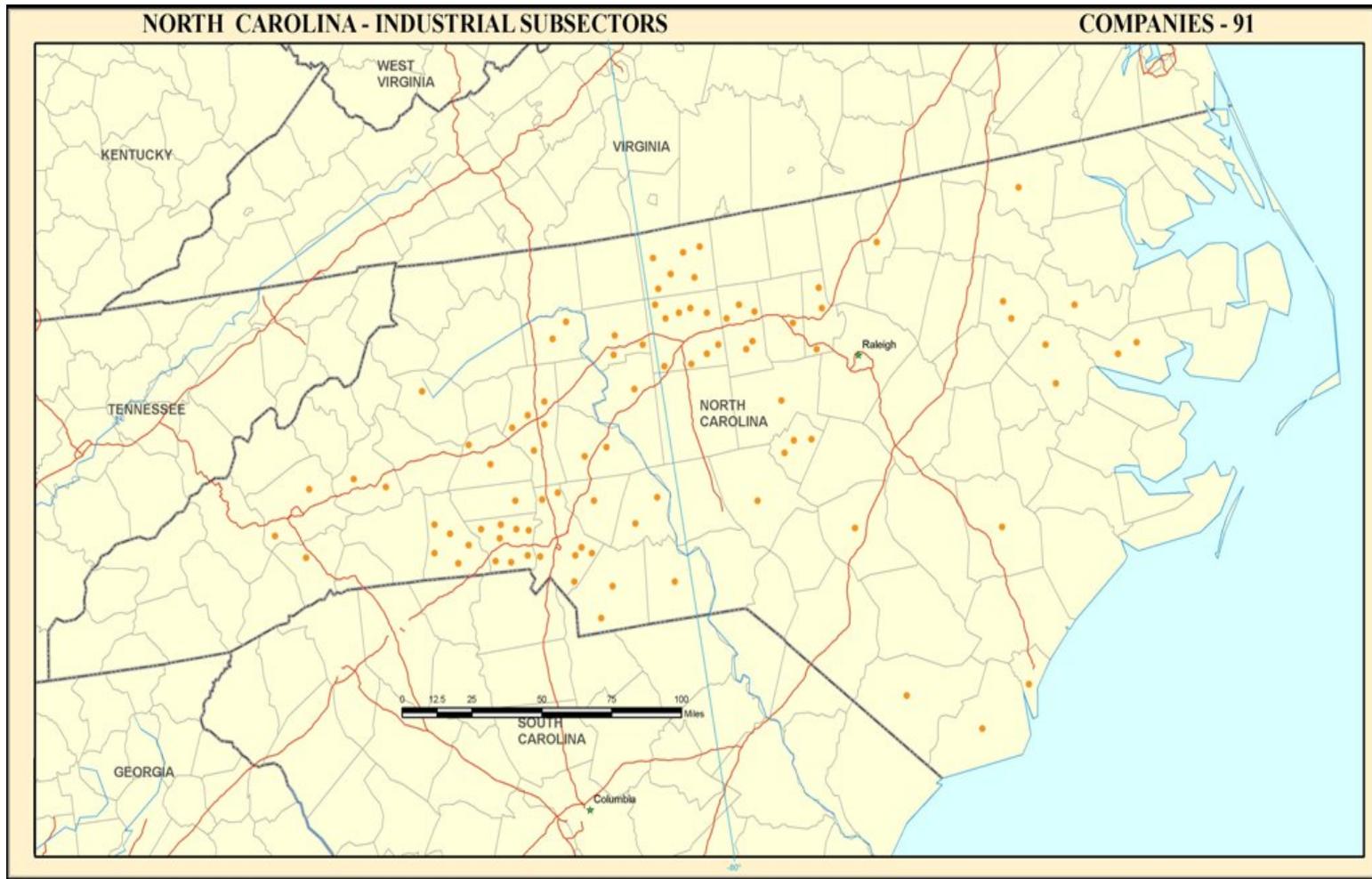


Figure 26 Industrial Cluster

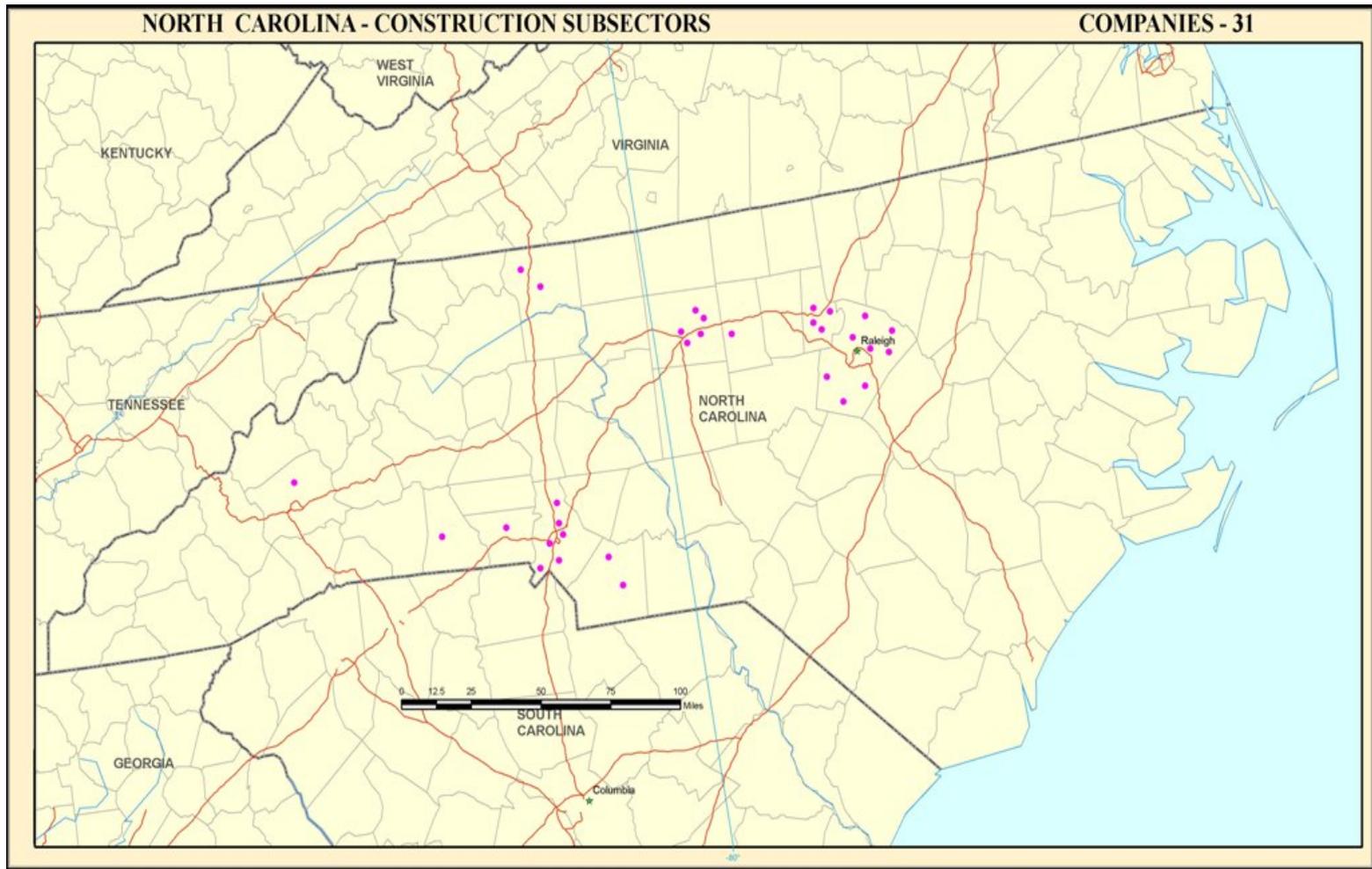


Figure 27 Construction Cluster

Phase II-Concurrent Triangulation Strategy

Primary data for Phase II were gathered from forty one companies and forty two respondents. The questionnaire used to moderate the focus groups was developed using both deductive and inductive logic. Table 26 provides detailed information about the sample including sector, company identification, sales for 2006 and number of employees.

Table 26 *Phase II Focus Group Sample Selection Information*

Sector	Company	Location	Sales for 2006	Number of Employees
Medical	A	N. Carolina	N/A	N/A
Medical	B	N. Carolina	\$0.00	10
Medical	C	N. Carolina	\$2,394,497.00	23
Medical	D	N. Carolina	\$600,000	8
Medical	E	N. Carolina	\$3,400,000.00	3
Medical	F	N. Carolina	N/A	N/A
Medical	G	N. Carolina	N/A	N/A
Medical	H	N. Carolina	\$16,600,000	150
Medical	I	N. Carolina	\$745,324,410.00	2767
Medical	J	N. Carolina	N/A	N/A
Medical	K	N. Carolina	\$1,500,000	8
Protection	L	N. Carolina	\$43,067,202.00	286
Protection	M	N. Carolina	N/A	3
Protection	N	N. Carolina	N/A	N/A
Protection	O	N. Carolina	\$96,800,000	100
Protection	P	N. Carolina	N/A	2711
Protection	Q	N. Carolina	N/A	N/A
Protection	R	N. Carolina	N/A	N/A
Protection	S	N. Carolina	N/A	N/A
Protection	T	N. Carolina	\$21,800,000	300
Protection	U	N. Carolina	N/A	N/A

Table 26 (continued) Phase II Focus Group Sample Selection Information

Protection	V	North Carolina	\$3,400,000.00	3
Protection	W	North Carolina	\$10,000,000	100
Construction	X	North Carolina	\$24,000,000.00	130
Construction	Y	North Carolina	N/A	N/A
Construction	Z	North Carolina	298419680	1980
Construction	A1	North Carolina	298419680	1980
Construction	B1	North Carolina	\$164,667,600.00	1200
Construction	C1	North Carolina	N/A	N/A
Construction	D1	North Carolina	N/A	N/A
Construction	E1	North Carolina	N/A	N/A
Construction	F1	North Carolina	N/A	N/A
Industrial	G1	North Carolina	\$0	20
Industrial	H1	North Carolina	N/A	700
Industrial	J1	North Carolina	N/A	570
Industrial	K1	North Carolina	\$11,000,000.00	66
Industrial	L1	North Carolina	\$16,800,000	180
Industrial	M1	North Carolina	N/A	N/A
Industrial	N1	North Carolina	N/A	N/A
Industrial	O1	North Carolina	\$15,500,000	70
Industrial	P1	North Carolina	\$42,570,000.00	1133
Industrial	Q1	North Carolina	\$60,137,700	100

Source: Author (Nelson 2007) adapted from North Carolina Textile Complex Database

Companies represented in the focus group were from the medical, protection, industrial, and construction (geo-textile) sector of the North Carolina performance textile

complex. Table 27 is a breakdown of the percentage of respondents from each sector.

Table 27 *Percentage of Respondents/Sample Size by Sector*

Sector	Percentage/n
Medical	26%/ 11
Protection	29%/12
Construction	21%/9
Industrial	24%/10

The research sample contains many of the leading performance textile companies in North Carolina. The largest representation of companies was from the protection sector, with companies that provide protective products and supply to end markets that provide safety against cuts, abrasion, ballistic and other forms of impact, fire and heat, hazardous materials, electricity, weather, cold, and poor visibility (Chang & Kilduff, 2002). The second largest representation consisted of the medical sector. This sector included companies that produce or market products to the hygiene and highly specialized medical market. The industrial sector had the next largest representation and included companies that produce textiles used directly in industrial processes or incorporated into industrial products such as filters, conveyor belts and abrasive belts, as well as reinforcements for printed circuit boards, seals and gaskets, and other industrial equipment (Horrocks and Anand, 2000). The construction (geotextile) sector had the least representation and accounted for companies participating in the production of geosynthetics, geogrids, geomembranes, and textiles used in commercial and residential commercial applications.

The following provides the aggregated results of Phase II focus groups.

North Carolina State University's College of Textiles held four focus groups dedicated towards understanding the protective (military), industrial, medical, and geotextile performance market segments in North Carolina on February 18th and 19th, 2008, in the RENCI computing facility. Phase II focus groups provided industry with the opportunity to discuss current and future business development opportunities as well as provide the North Carolina Department of Commerce with strategies for assistance.

Forty two industry representatives attended the focus groups and represented forty one North Carolina companies. A total of 12 participants attended the protective (military focus group) and 11 participants attended the medical textile focus group; both were held on February 18th from 9-11am and 1-3 pm respectively. On February 19th, 7 participants attended the industrial textile focus group from 9-11am and 8 participants attended the geotextile focus group from 1-3 pm. Focus group discussions were supplemented with six telephone interviews and one email interview. Participants included industry leaders, consultants, and association representatives. Additionally, NC State faculty, graduate students, and North Carolina Department of Commerce project managers were invited to listen to the discussions.

The primary focus group moderator was an industry executive with approximately 40 years of experience in the textile and apparel industry. Holli Nelson, graduate student, helped to guide the discussion as well. Each two hour focus group was centered on four distinct areas vital to understanding the market structure and its' needs. These topics included: global competitiveness factors, growth potential, market trends, innovation, added value, quality,

standards, technical performance, industry needs, and recommendations.

The Protective (Military) market was the most dynamic of the four focus groups, thus reflecting the complexity and challenges of that market. Opportunities for innovation and growth are apparent in this segment. Challenges are associated with navigating the government bureaucracy. Also, connectivity throughout the supply chain is an issue. There is a need for a better connection between product development and the end user.

The Medical textile segment was equally intriguing, but more reserved in its overall tone. The focus group unanimously agreed this sector was a growth market for the state. Driving forces for the medical market included: the ageing population, the war in Iraq, returning soldiers, infection control, functional products, over the counter medications, anti viral, anti bird flu, corporate America's need to protect employees, chemical warfare, consumer lifestyle changes, shorter operating times, less invasive surgeries, the lack of technical equipment/machinery for innovative medical products, and athletic performance enhancement.

Challenges are present in this sector as well. Challenges include understanding government regulations, persuading health organization buying offices for product acceptance, and long product development cycles. The medical market focus group agreed that finding a trained workforce is becoming an increased challenge due to the stigma associated with the textile industry and the State's own drive to attract workers to biotech and other high tech segments.

The participants in this group all gave the impression that they are succeeding in spite of the challenges. The firms were quite specialized and exuded trade leadership in their

niche.

The Industrial textile focus group was smaller than the others in number, but populated with industry leaders who exemplified reorientation strategies in terms of shifting from commodity production to specialty products. Innovators in the group represented radical product innovations created to meet the needs of the market.

The topic of sustainability was an important discussion driver and opportunities and challenges were discussed in terms of the applicability of sustainable products and processes to the industrial market. Legitimate third party testing and certification also proved to be a relevant topic, as did the workforce issues that had been raised by previous groups.

The final focus group examined textiles for construction and civil engineering. This segment is driven by textile products used in geotextile applications and in terms of this market; many of these products are believed to be commodities. Opportunities for innovation and specialization exist, yet this process is difficult due to specification standards and limitations. Most of the product in this market is specified, in many cases by government agencies, where the best long term solutions are overshadowed by budget constraints.

Phase II focus groups indicated and further validated the significant presence of the performance textile industry in North Carolina. Additionally, there is a significant interest in growing the performance textile cluster. In order to achieve sustained growth in terms of the performance textile industry in North Carolina, there are five general needs that must be addressed:

1. Increased innovation communication (Innovation partnerships with academia, commerce, industry, and entrepreneurs).

2. Commercialization assistance (Assistance in bringing innovations, new products, and technologies to market).
3. Workforce recruitment, retainment, and development (Attract workers to the performance textile industry).
4. Increased promotion of www.nctextileconnect.com and the availability of statewide networking sessions for business partnerships, development, and supply chain needs.
5. Development of a more attractive business environment in North Carolina.

Step 7: Updated cluster analysis of opportunistic sub-sectors

Throughout phase II data collection, additional companies were identified, validated and segmented for placement in opportunistic sub-sectors. Additional companies were added to the protective, medical, industrial and construction sub-sector based on focus group validation and sample selection research. The cluster maps and statistics provided updated (2008) cluster dispersion for each growth sub-sector. Specific focus group results are provided with each updated map in order to provide a holistic understanding of each sub-sector at present.

Protection (Military) Sub-Sector

Number of companies: 172

Phase I identified 91 companies competing in the protection (military) sub-sector of the North Carolina performance textile complex. Phase II identified 81 additional companies competing in the sector, increasing company representation to 172 locations.

Number of counties: 55

Phase I identified 33 counties competing in the protection (military) sub-sector of the North Carolina textile complex. Phase II identified 20 additional counties with company locations in the protection (military) sector, increasing counties representation to 55 counties.

Cluster configuration: Guilford, Wake, Mecklenburg, Buncombe

The cluster configuration remained similar in geographic dispersion as compared to Phase I results.

Sales \$ (estimated): 4,500,000,000

Estimated sales for Phase I were \$1,607,474,400. With Phase II identification, estimated sales increased by approximately 3 billion dollars.

Employees: 15,645

Phase I identified 4,744 employees working in the protection (military) sector. Phase II determined there were approximately 10,000 more employees associated with the protection (military) sector.

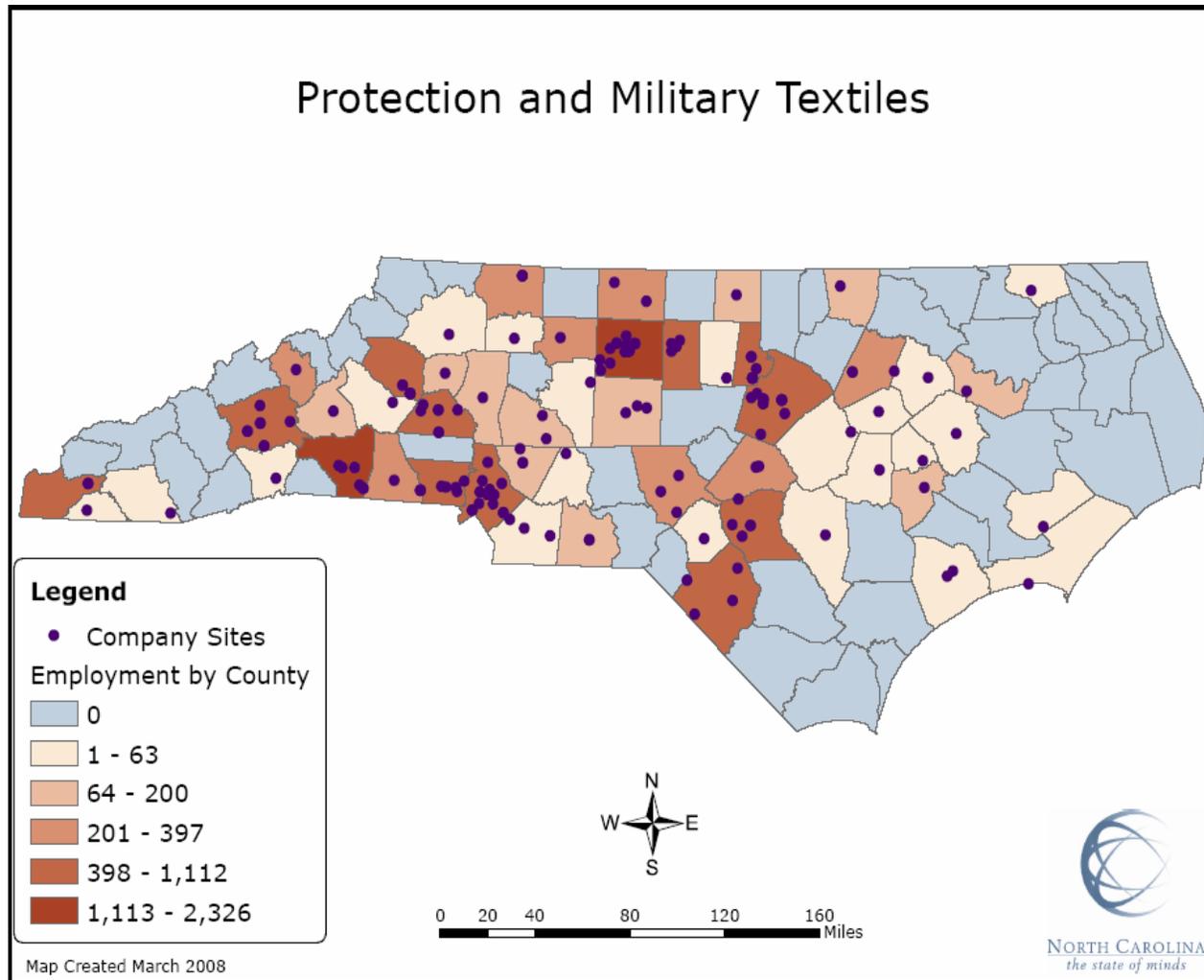


Figure 28 Protection and Military Textiles Updated Cluster Map

Protection (Military) Textile Focus Group Findings

Section 1: Global Competitiveness Factors, Growth Potential, and Market Trends

- Trends affecting the protective (military) market include: foreign competition, supply chain difficulties, foreign manufacturing relationships, commercialization processes, the cyclical nature of supplying to the military, and the impending election.
- Also, the ease of supplying to foreign military markets is a trend in this sector. Companies find supplying to allied countries can have fewer barriers to entry than supplying domestically. This is an opportunity for all companies.
- In terms of the impending election there are issues specific to the Department of Defense's budget level, political differences, and procurement levels. The 2008 election could prove to be disruptive for this market.
- To be competitive, companies cannot only supply to the military market. Protective applications in all forms are the key to competitive advantage in the Western Hemisphere.
- The Berry Amendment plays a major role in the protective market. Companies must be proactive in keeping the Berry Amendment intact. Additionally, certain waivers to the Berry Amendment are critical to companies' success and competitiveness. The key theme associated with the Berry Amendment is the continued need to fully understand the legislation and use the legislation advantageously.
- Growth opportunities for the protective market include: ballistic protection, silver technology, armor plating, AMWRAP vehicles, anti-coagulates, composites, anti-radar, anti radiation, comfort, climate protection, function, and degradation of fiber

abrasion.

- In terms of apparel, export opportunities exist in the form of workwear.
- Growth potential for this sector in terms of connecting global technologies is integral at the University level. Dissemination of global research to North Carolina companies is needed. This will allow companies to stay ahead of the innovation curve and be proactive in the development of appropriate technologies.

Section 2: Innovation, Added Value, Advanced Manufacturing

- In this sector, there is not a method for radical innovations. Radical, disruptive innovations are difficult to push through in this market.
- Innovation is often driven through proposals, grants, and research incentives.
- Additionally, innovation is driven by the specification of standards. Adhering to specifications and standards can discourage radical innovation.
- In terms of this sector, technology is most successful if it is pulled through the supply chain by the final customer. Innovation stems from providing solutions to the needs of the military, first responders, and other protective workforces.
- For the protective market, demand push exists in innovations with disruptive technologies that could be taken to the military; then bridged into other technologies (process innovations and line extensions).
- Entrepreneurs and young innovative companies are pushing innovation on to the final customer.

Section 3: Quality, Standards, Technical Performance

- Developing new specifications is a challenge in this market. Many specifications are

old or written for a specific company.

- There needs to be continued communication about specifications in order to begin developing a level playing field.
- In terms of testing, there is a need to demonstrate at an ensemble level. Testing of all components is important, but testing a complete ensemble is most beneficial in terms of understanding comfort, climate, and movement.
- A challenge for testing processes is speed. There is a need for better testing access, quick turn around in labs, and help with prototype development.
- TPACC at NCSU has the ability to do the type of testing needed for the protective market. A challenge is expense.

Section 4: Industry Needs, Next Steps, Recommendations

- North Carolina is advantageous to the protective/military market because of its' infrastructure and the critical mass of textile companies.
- Companies competing in this market need: facilitation of communication in terms of R&D, innovation, and technological advances, help with commercialization, ballistics testing facility, a better understanding of the end user's needs, a role in developing specifications, better communication with procurement officials, and incentives for innovation.
- In developing future seminars, meetings, or forums companies competing in this market want information specific to: the needs of the industry, the needs of the military, and the needs of the customer. Seminars devoted in entering foreign military markets would be helpful, in addition to commercialization and new product

development seminars.

- Strategic military meetings are needed. Topics and speakers should include: procurement leaders, Berry Amendment experts, export assistance in terms of allied military markets, specification development assistance, technical reports on new, global innovations, and standards.
- North Carolina State University could serve as a partnering body. If the University understands the core competencies of a company, they can develop partnerships and strategic alliances with other companies.
- An increased promotion of Textile Connect (www.textileconnect.com) is needed.

Medical Sub- Sector

Number of companies: 140

Phase I identified 92 companies competing in the medical sub-sector of the North Carolina performance textile complex. Phase II identified 48 additional companies competing in the sector, increasing company representation to 140 locations.

Number of counties: 38

Phase I identified 30 counties competing in the medical sub-sector of the North Carolina textile complex. Phase II identified 8 additional counties with company locations in the medical sector, increasing counties representation to 38 counties.

Cluster configuration Guilford, Wake, Mecklenburg, Catawba

The cluster configuration remained similar in geographic dispersion as compared to Phase I results.

Sales \$ (estimated): 7,000,000,000

Estimated sales for Phase I were \$1,513,621,608. With Phase II identification, estimated sales increased by approximately 5.5 billion dollars.

Employees: 15,494

Phase I identified 6,117 employees working in the medical sector. Phase II determined there were approximately 10,000 more employees associated with the medical sector.

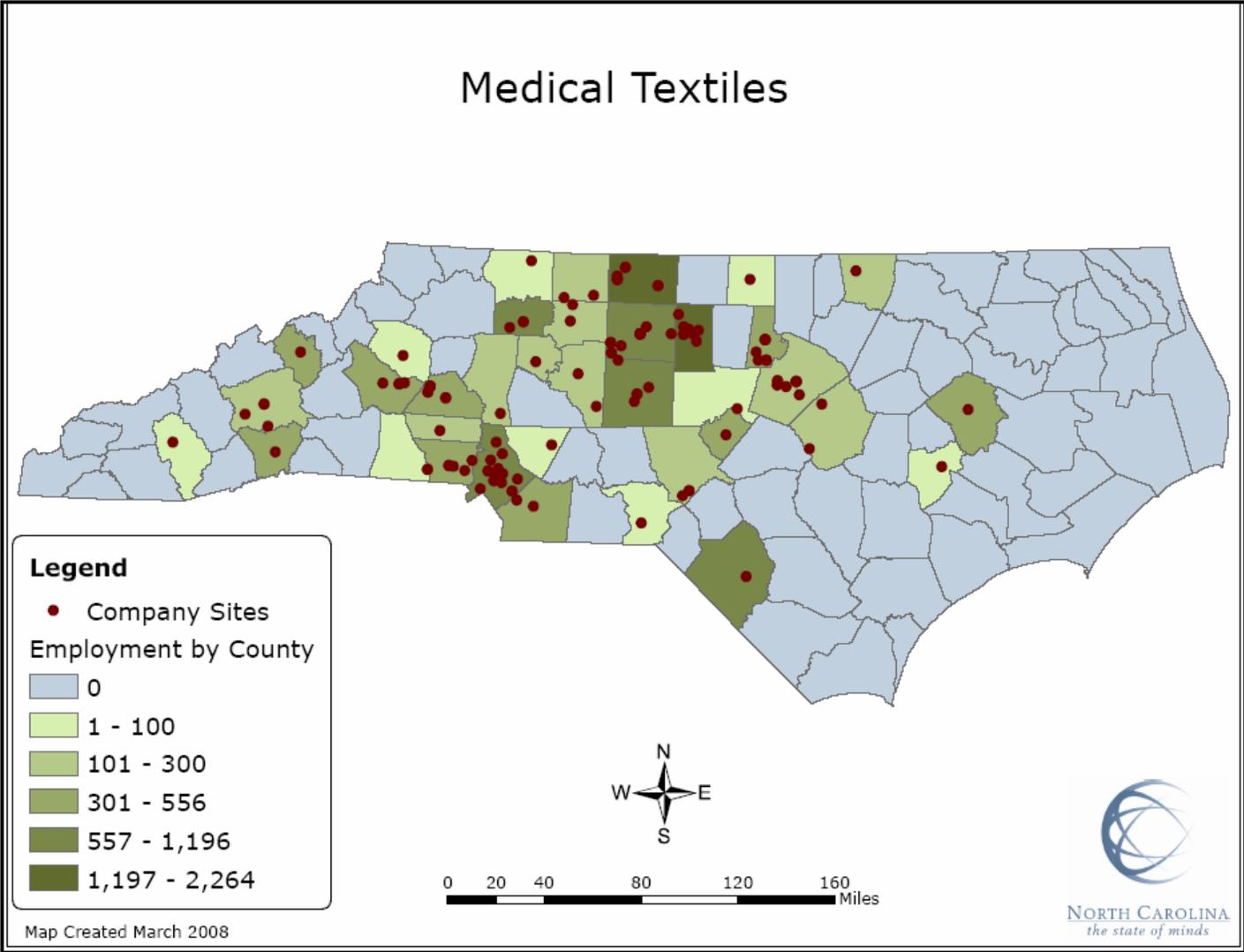


Figure 29 Medical Textile Updated Cluster Map

Medical Textile Focus Group Findings

Section 1: Global Competitiveness Factors, Growth Potential, and Market Trends

- Market trends affecting the medical textile market include: the lack of raw material, the aging population, the war in Iraq, returning soldiers, infection control, functional products, over the counter medications, anti viral, anti bird flu, corporate America's need to protect employees, chemical warfare, consumer lifestyle changes, shorter operating times, less invasive surgeries, the lack of technical equipment/machinery for innovative medical products, and athletic performance enhancement.
- Competitiveness factors include: the availability of raw materials, lack of technical expertise in the workforce, dispersed ancillary services, the FDA, the consolidation of the warp knitting machinery industry, and hospital reimbursement.
- The medical market has one of the largest barriers to entry. It is an expensive market, requires long product development lead times, and switching costs are high.
- Competitiveness can be achieved through value pricing. Quality is very important in this sector. Buying groups, hospitals, and insurance companies must be educated on the price/value ratio and the need for value enhanced products.
- Competitive products must be evaluated on a cost per use basis. The lifecycle of a product must be taken into consideration. The lowest cost product is not always the best choice in long term situations.
- The price balance is a challenge in this industry. If a product is priced at the lowest cost, it can be viewed as a commodity product. Increasing the price often commands an increased sense of value. Price is not as important in the medical market,

especially niche medical markets. There is room for the best product in this sector, no matter the price.

- As a whole the medical market is a growth opportunity. The medical market provides a venue for quality textile products. Growth opportunities include supplying to the military, providing products that are radically innovative, protection from bird flu, viruses, infection, infection associated with food control, developing countries, and self medication/self diagnosis.
- Also, the cross over between the medical industry and the veterinary industry is a growth opportunity.

Section 2: Innovation, Added Value, Advanced Manufacturing

- Success factors for product development for the medical market include: meeting the patient's needs, developing a successful product, adequate funding, commercial distribution, and product placement.
- Entrepreneurs for the medical market are pushing technology through the supply chain to the final customer.
- Innovations also stem from the needs of doctor, surgeons, and patients. Innovations derive from improved medical tools, processes, and the need for quicker surgeries, less invasive operations, and faster healing times.
- Most often a need in the market is uncovered and technologies are developed or improved upon to meet this need.
- Replacement materials (fibers) for traditional applications are characterized by the growth stage of the Innovation Lifecycle.

- Innovative manufacturing processes and equipment are needed to commercialize products. Machinery innovations are used to improve current medical tools and add value to traditional tools. Fabric finishing for medical applications also adds value to the manufacturing process.

Section 3: Quality, Standards, Technical Performance

- In terms of quality, standards, and technical performance, one of the key themes was associated with third party certification parties used in justifying cost per use data.
- Companies need credibility for marketing the value associated with their products. Validation of cost per use is important for persuading buying groups, insurance companies, doctors, surgeons, and hospitals to specify new products.
- In the medical industry, standards can inhibit innovation and competitive advantage. Standards deter growth because one cannot demonstrate superiority.
- Additionally, consumers need to be educated. The market is saturated with anti-microbial, wicking materials, climate control, odor control, etc. Do consumers really know what all of this means? Do they want of all these characteristics? Consumers have no understanding of standards.
- Retailers, brands, and marketing programs devalue technical characteristics such as wicking and antimicrobial.
- The FDA is difficult to work with, yet FDA approval is critical for success. Approval committees are helpful, but the process can be time consuming.
- Human trials are sometimes needed in terms of testing and this can be very expensive.

Section 4: Industry Needs, Next Steps, Recommendations

- The major advantages of doing business in North Carolina include: the proximity to the University and community college system, labor availability, textile engineering expertise, customer base, and manufacturing facilities.
- A challenge of doing business in the state is the dispersion of technological skill. As the textile industry has dispersed, the skill of the workforce has also dispersed. Additionally, certain skill sets are disappearing as the workforce ages.
- Employees who have lost textile jobs are hesitant to re-enter the textile workforce. Companies must be creative in the recruitment of employees. Companies attract employees by advertising itself as a medical company, biomedical company, or chemical company.
- A need for the continued promotion of manufacturing jobs as a viable career path is critical for continued growth in terms of the medical market.
- Recruitment in middle and high school is important. Choices other than a 4 year college degree are needed. There is a need for trade school and vocational opportunities. The North Carolina education system needs to advocate other options besides a 4 year degree from a University.
- Future seminar topics specific to the medical market should include: information on R&D, raw material supply, acquiring FDA certification, entering international markets, distribution, product placement, connectivity, improving processes, chemical based innovations, and the State's capabilities for supporting this industry.
- The State could further develop the medical sector by offering economic incentives,

research grants, and funding opportunities. Technology needs to be linked with entrepreneurs and venture capitalists. Confidentiality is a factor.

- Network opportunities are needed with patients, doctors, surgeons, buying groups, insurance companies, and hospitals.
- An increased promotion of Textile Connect (www.textileconnect.com) is needed.

Industrial Sub- Sector

Number of companies: 285

Phase I identified 273 companies competing in the industrial sub-sector of the North Carolina performance textile complex. Phase II identified 12 additional companies competing in the sector, increasing company representation to 285 locations.

Number of counties: 55

Phase I identified 52 counties competing in the industrial sub-sector of the North Carolina textile complex. Phase II identified 3 additional counties with company locations in the industrial sector, increasing counties representation to 55 counties.

Cluster configuration Guilford, Wake, Mecklenburg, Catawba

The cluster configuration remained similar in geographic dispersion as compared to Phase I results.

Sales \$ (estimated): 12,500,000,000

Estimated sales for Phase I were \$7,887,113,398. With Phase II identification, estimated sales increased by approximately 4.7 billion dollars.

Employees: 37,173

Phase I identified 29,097 employees working in the industrial sector. Phase II determined there were approximately 8,000 more employees associated with the industrial sector.

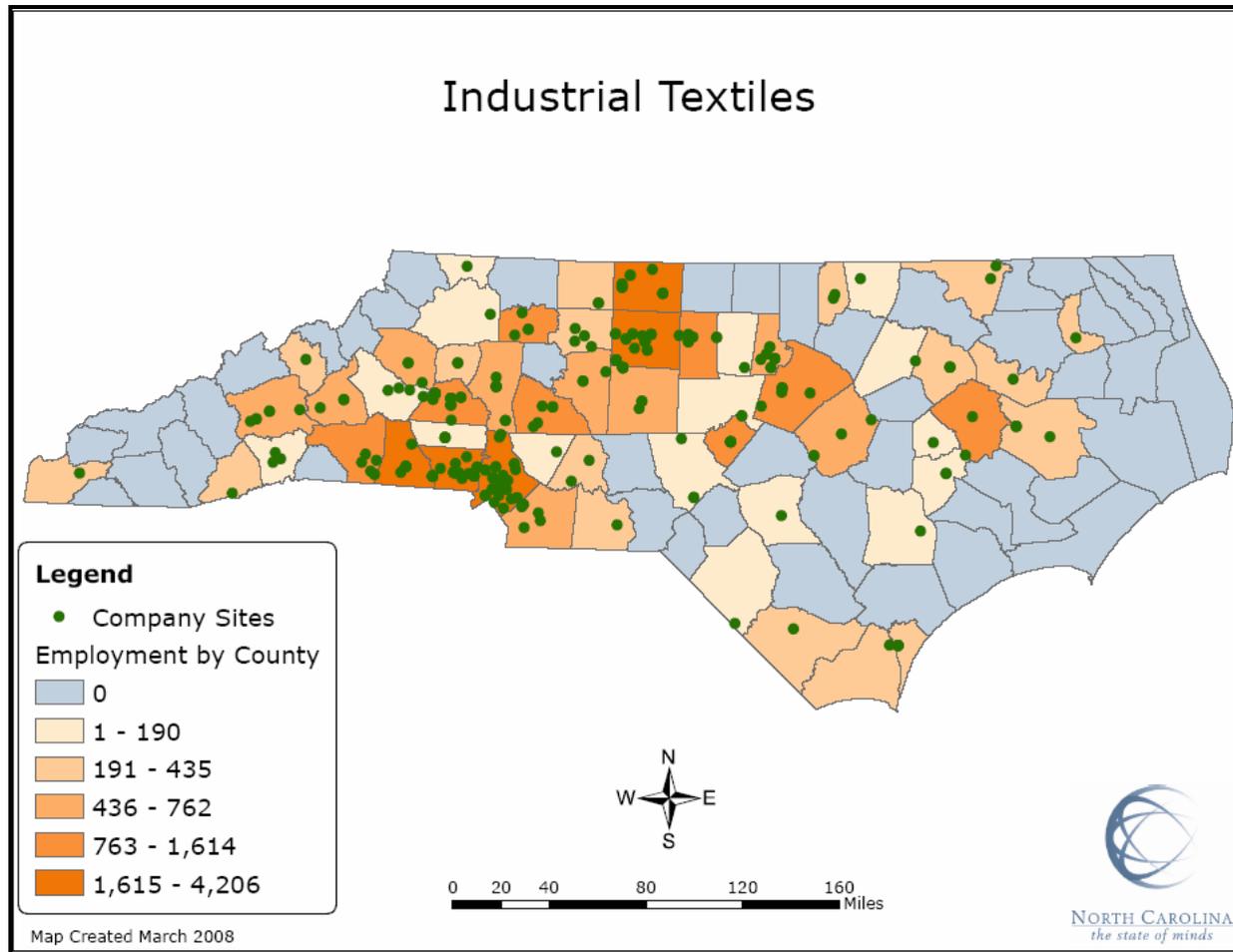


Figure 30 Industrial Textile Updated Cluster Map

Industrial Textile Focus Group Findings

Section 1: Global Competitiveness Factors, Growth Potential, and Market Trends

- Oil prices, economic cycles, import competition and the consolidation of the domestic textile industry are trends that have impacted the industrial textile market.
- Specifically, the availability of raw materials is a trend that impacts pricing, manufacturing, and product market selection.
- Competition from China was a key theme in terms of fiber availability, cost pressure, new machinery demands, and intellectual property.
- Additionally, China has the opportunity to challenge domestic nonwoven manufacturing in the next 3 years.
- Foreign government subsidies provide challenges for domestic manufacturing and business development.
- Growth potential for the industrial market is specific to niche markets, the nonwovens industry, supplying the military, ballistic protection, flame retardant products, replacement fibers and materials, and value added fibers.
- In terms of the nonwovens industry, growth potential is linked to baby diapers, medical procedures (less invasive procedures), the automobile industry, providing opportunities for products that are lighter weight and less expensive and the apparel market.
- The competitiveness factors that are most important to the industrial textile market include: innovation and technological ability, economic stability, skill of the workforce, and intellectual property.

- Competitiveness in the industrial textile market is achieved through: product selection, providing a wide portfolio of products, quick reaction time to market trends, flexibility in manufacturing, partnerships throughout the supply chain, and providing a competitive price/performance ratio. Overall, if the price is not right, then the quality and product function is insignificant.
- The “green” movement is becoming a business driver. Companies are forced to improve their sustainable scorecard and carbon footprint. Green movement has become a reality, not a fad. Market research states that consumers will pay MORE for sustainable products. This is an opportunity for the market.
- There is a learning curve associated with the green movement. Consumers demand products in an ideal state; green, recyclable, cradle to cradle, etc. This is difficult to achieve at the mill level in terms of economic, cost, and speed barriers.

Section 2: Innovation, Added Value, Advanced Manufacturing

- Companies agree that awareness of the types of innovation and the innovation process is critical for sustainable growth opportunities. The textile industry as a whole has generally lagged in terms of technology advancements. Traditionally, the textile industry has focused on marketing strategies, not innovation strategies.
- Companies agree that radical innovations are always sought after, but generally process innovations occur more often achieved.
- Radical innovations can be achieved through new polymer and new fiber developments.
- Partnerships with the engineering industry are important in terms of innovations.

- Innovation is a combination of both market pull and technology push.
- In terms of successful innovations, generally a market pull approach is 50% successful while a technology push approach is 20% successful.
- In the industrial market, radical innovations can stem through motivated customers or through internal innovation strategies.
- Commercializing new products is a challenge; bringing radical innovations to market can be difficult.
- In terms of machinery development, innovation is achieved through partnerships with the end customer. End customers then force suppliers to purchase certain machinery and equipment.
- Value is added in the manufacturing process by providing flexible production strategies, running several products simultaneously, and adding performance coatings/finishing. Efficiency in the manufacturing process provides added value as well as a competitive advantage. Efficiency is often achieved through investments in new machinery.
- Manufacturing value can also be achieved by providing suitable, consistent products in order to achieve trade leadership.
- For a radical innovation or new product to be successful, a company must tie together all aspects of the supply chain.
- Innovation strategies are also used in the marketing and merchandising of new products and fibers. Branded fibers allow for a pull through in downstream relationships.

- 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.
- All agree that the nonwovens industry is characterized as a growth market in relation to the Innovation Lifecycle. In terms of nonwoven consumer products, the lifecycle is short but provides for various line and product extensions.
- Creating a “needs” list is important for developing innovations. Companies must stay current with customer needs and market needs.
- Transaction innovations can be achieved through an integrated supply chain. Speed is important in terms of supply chain innovations. Technical innovations can be achieved through tweaking existing products in terms of finishing, additives, and functionality. Non technical innovations are achieved through branding and marketing strategies. Opportunities exist in non technical innovations.

Section 3: Quality, Standards, Technical Performance

- There is a need to be proactive in creating an industry organization devoted to establishing standards, test methods, and quality certification.
- The nonwovens industry has been proactive in developing definitions and test methods. This is an opportunity for the textile industry. All aspects of the supply chain must work together in the development of standards and test methods.
- Guidance in terms of sustainability requirements and definitions is needed. Consumers need a better understanding of sustainable as well.

- Third party testing bodies are needed for validation. In terms of competitiveness, third party validation is important for credibility. NCSU, HTC, and Gaston Textile Technology Center are three places in the state that this can be done.
- Third party testing facilities can be difficult to work with. Difficulties include: turn around time, market acceptance, confidentiality, expense, problematic terms and conditions, dogmatic legal aspects, access to expertise and accommodations of the needs of companies.
- Suggestions for improving third party testing facilities include: readjusting the sense of urgency, correlation between payment and research quality, personal liaisons to ensure progress, ongoing dialogue, hands on management, and vested interest between the organization and the company.
- Have NCSU as third party authority provides advantages and credibility in the market acceptance of new innovations, technologies, and products.

Section 4: Industry Needs, Next Steps, Recommendations

- Advantages of North Carolina include: transportation, University and community college system, existing textile workforce, State incentives, and the port system.
- Challenges of doing business in North Carolina include: electrical costs, mentality associated with the “death of the textile industry”, retaining workforce, recruiting manufacturing workforce, and high taxes.
- A key theme associated with this focus group included the workforce in North Carolina. There is an access to intelligent, high skill workforce. There is a need for continued recruitment of entry level workers. Many are skeptical to work in the

- textile industry because of the textile stigma. There is a need to change the workers' mindset. The state needs to make manufacturing jobs more attractive.
- The competitiveness of South Carolina was discussed. Companies believe South Carolina does a better job in recruiting companies and employees. The South Carolina textile industry is more aligned with the government. There is a strong effort in South Carolina to help the textile industry.
 - North Carolina needs to reposition itself. There is too much focus on the Research Triangle Park area. North Carolina needs to think about its core competencies (textiles) and rebuild companies around these competencies. Textiles are and will be a viable industry; the perception of the state must reflect this.
 - Possible seminar topics include: new polymer technologies, new fiber forming technologies, and understanding the sustainable movement.
 - Suggestions for the creation of a statewide “needs” list. What do customers need? What do consumers need? What does the military need? What do other market segments need?
 - There needs to be a better understanding of the type and level of research done by the Universities. Better research communication can lead to partnership opportunities. There needs to be a synergy between the Universities, industry, entrepreneurs, and the Department of Commerce.
 - North Carolina needs to be more proactive in recruiting companies to the State. The Charlotte area is very attractive for the industrial sector.
 - An increased promotion of Textile Connect (www.textileconnect.com) is needed.

Geotextile, Construction, Agriculture Sub- Sector

A key finding from the construction (geotextile) focus group was a refined definition of the market structure. Focus group participants agreed that there is a large overlap in terms of the end products used in the construction, geotextile, and agricultural market segment. In fact, one participant (telephone interview) described the sectors as “three intersecting rings”. From this information and feedback, the geotextile, construction, and agricultural performance textiles sectors have been combined; thus creating a more dynamic sector as well as one with greater economic impact and scale.

Number of companies: 59

Phase I identified 107 companies competing in the combined geotextile, construction, and agricultural sub-sectors of the North Carolina performance textile complex. Phase II identified 59 companies competing in the sector. Overlap in company representation provided for a decreased number of companies identified in Phase II, yet provides a more realistic representation of this sector’s dispersion throughout the state.

Number of counties: 21

Phase I identified 46 counties competing in combined geotextile, construction, and agricultural sub-sectors of the North Carolina performance textile complex. Phase II identified 21 counties competing in the sector. Overlap in county representation provided for a decreased number of counties identified in Phase II, yet provides a more realistic representation of this sector’s dispersion throughout the state.

Cluster configuration Guilford, Wake, Mecklenburg, Durham

The cluster configuration remained similar in geographic dispersion as compared to Phase I

results.

Sales \$ (estimated): 1,200,000,000

With Phase II identification and consolidation, estimated sales are more accurate for the geotextile, construction, and agriculture sector.

Employees: 5,496

With Phase II identification and consolidation, employment estimates are more accurate for the geotextile, construction, and agriculture sector.

Geotextiles, Construction, and Agricultural Textiles

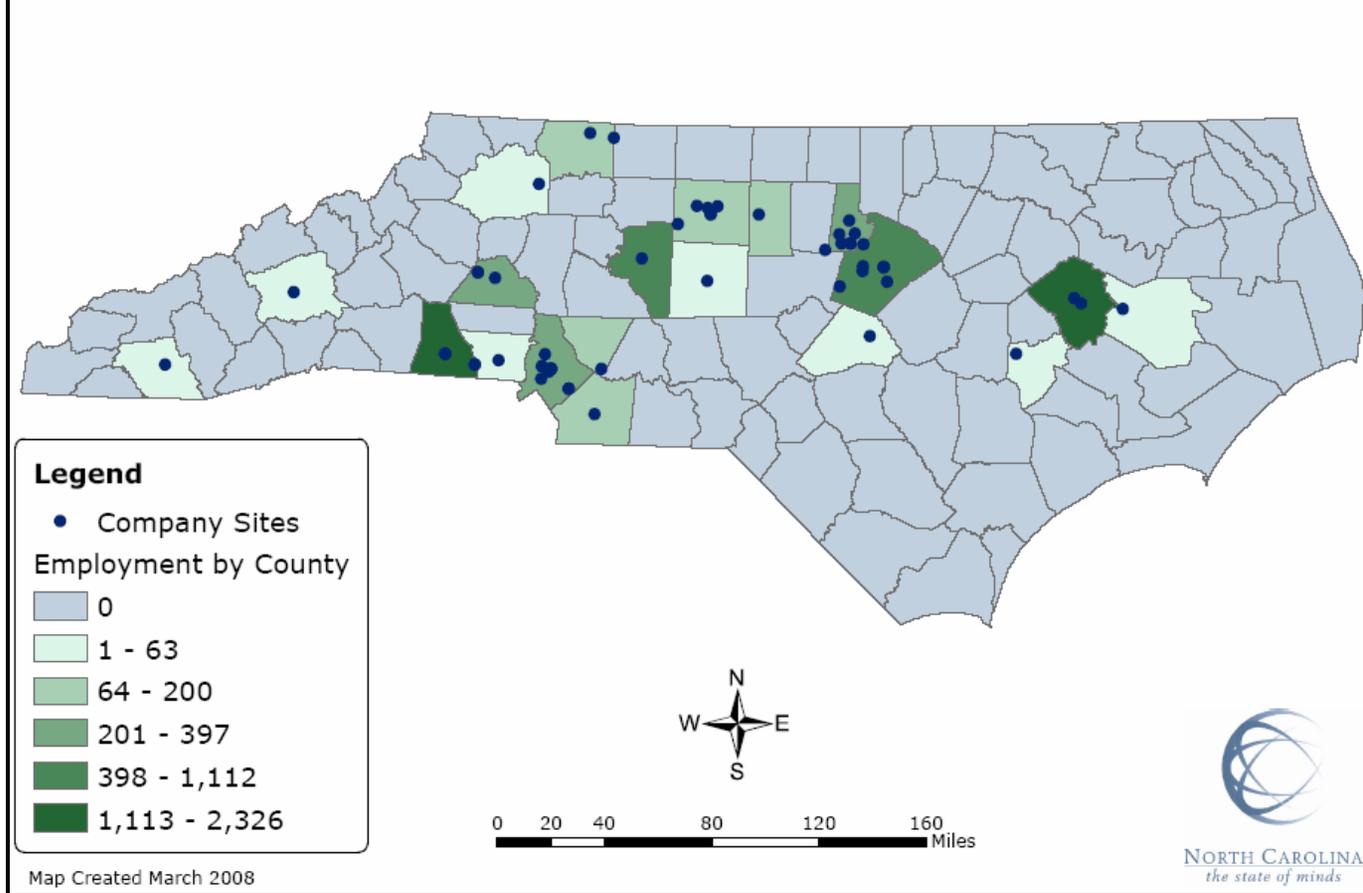


Figure 31 Geotextile, Construction, and Agricultural Updated Cluster Maps

Geotextile (Construction) Market Focus Group Findings

Section 1: Global Competitiveness Factors, Growth Potential, and Market Trends

- Market trends for the geotextile and construction include: increased labor costs, cyclical nature of the housing industry, the economy, climate change, a shift towards finer yarns, foreign competition, consolidation of the market, political environment, increased export opportunities in developing markets, and the movement towards eco-friendly products.
- Many geotextile products are considered commodities and are subject to increased off-shore competition especially from Asia.
- Competitiveness factors include: meeting regulatory requirements in terms of environmental needs, economic cycles, price, ability to prove cost savings, and the ability to sell performance.
- Competitiveness is achieved through the appropriate value proposition for a specific product. Value based pricing is important in this market. There is a need for cost comparison validation.
- Competitiveness is also achieved by convincing the public and private sector, as well as engineers to specify geotextile products.
- Growth opportunities include: construction applications, the Mexican market, export opportunities in Asia, providing specialty products to the Chinese market, products that give solutions to problems associated with population increases (waste, water, living area), sustainable products, and replacement materials.
- Export opportunities are idealistic for geotextile products; they are roll goods thus

easy to ship.

- Challenges associated with competing in this market include: the Department of Transportation, the ability to validate cost savings and the price/performance ratio, domestic innovation (too secretive), climate change (no longer a need for some products), and switching costs.
- As environmental concerns continue to escalate, there will be a growth in terms of demand for geotextile products. Meeting environmental needs is the basis for many geotextile products. The next step is to provide technical, innovative products to add value to the product's function.

Section 2: Innovation, Added Value, Advanced Manufacturing

- Generally, innovation in this market stems from process innovations and line extensions. Products that are improved through innovations are more likely to be specified because of its' uniqueness and function.
- Once a product has been standardized, there is a push to find new applications for products.
- The engineering industry is an important supporting sector in this market and often drives the pace of innovation and need for quality products.
- If an innovation occurs and a geotextile product becomes specified that product has the competitive advantage. This is difficult and is contingent upon commercialization times and speed to market.
- Innovation must merge science and marketing (technical and non-technical innovations). The industry needs help with this type of merger.

- Radical innovations are driven by mega-trends; ballistics, fiberglass, and the green movement. What is the next mega-trend?
- Radical innovations also occur in the woven geotextile sector.
- Innovation is pulled by the customer in most cases. What does the customer want?
There is a need to connect with the downstream customer in terms of innovating to meet needs.
- Push strategies include looking to other markets (complementary industries).
- Energy conservation, coal availability, and pollutants are also driving innovation.
- Value can be added in the manufacturing process by investing in new equipment and new product assembly lines. Thus, products can be converted more efficiently and economically.

Section 3: Quality, Standards, Technical Performance

- ASTM standards, military specifications, and GRI standards are important to the geotextile and construction market.
- GRI is an industry specific standard association.
- Companies need credibility for marketing the value associated with their products.
Validation of cost per use is important for negotiating with the Department of Transportation and Federal Highway Administration.
- Developing specifications for products is important for achieving competitive advantage and deterring from foreign competition.
- The geotextile supply chain is rather short; manufacturing to distributor to contractor.

Section 4: Industry Needs, Next Steps, Recommendations

- North Carolina is advantageous in terms of the geotextile sector because of the textile presence, highly educated workforce, access to ports, and the supply of raw materials.
- Working with the Department of Transportation is difficult and is one of the state's shortcomings in facilitating development in this industry.
- The tax system in North Carolina is not favorable to manufacturing and energy costs are high.
- Although geotextiles are generally nonwoven materials and North Carolina has a large nonwoven presence, this is not an advantage. Nonwoven manufacturing in North Carolina is not equipped to handle many of the large rolls needed to supply the geotextile market. An opportunity exists to meet this demand.
- Recommendations for the State include: networking sessions to locate manufacturers, understanding export opportunities, facilitating communication with the Department of Transportation, and understanding legislation.
- An increased promotion of Textile Connect (www.textileconnect.com) is needed.

Step 8: Refinement of Lifecycle of Innovation (2007) and the Textile Added Value Curve

Data collected from focus groups and secondary research was used in order to refine the conceptual model, Jacob's Lifecycle of Innovation (2007) and the Textile Added Value Curve (2006). Specific markets and product categories were plotted on the Innovation Lifecycle in order to validate its' applicability to the performance textile sector. Strategies discussed in Phase II focus groups were used to provide recommendations and examples for shifting value-added processes in the manufacturing stage of the Textile Added Value Curve.

Jacob's Lifecycle of Innovation

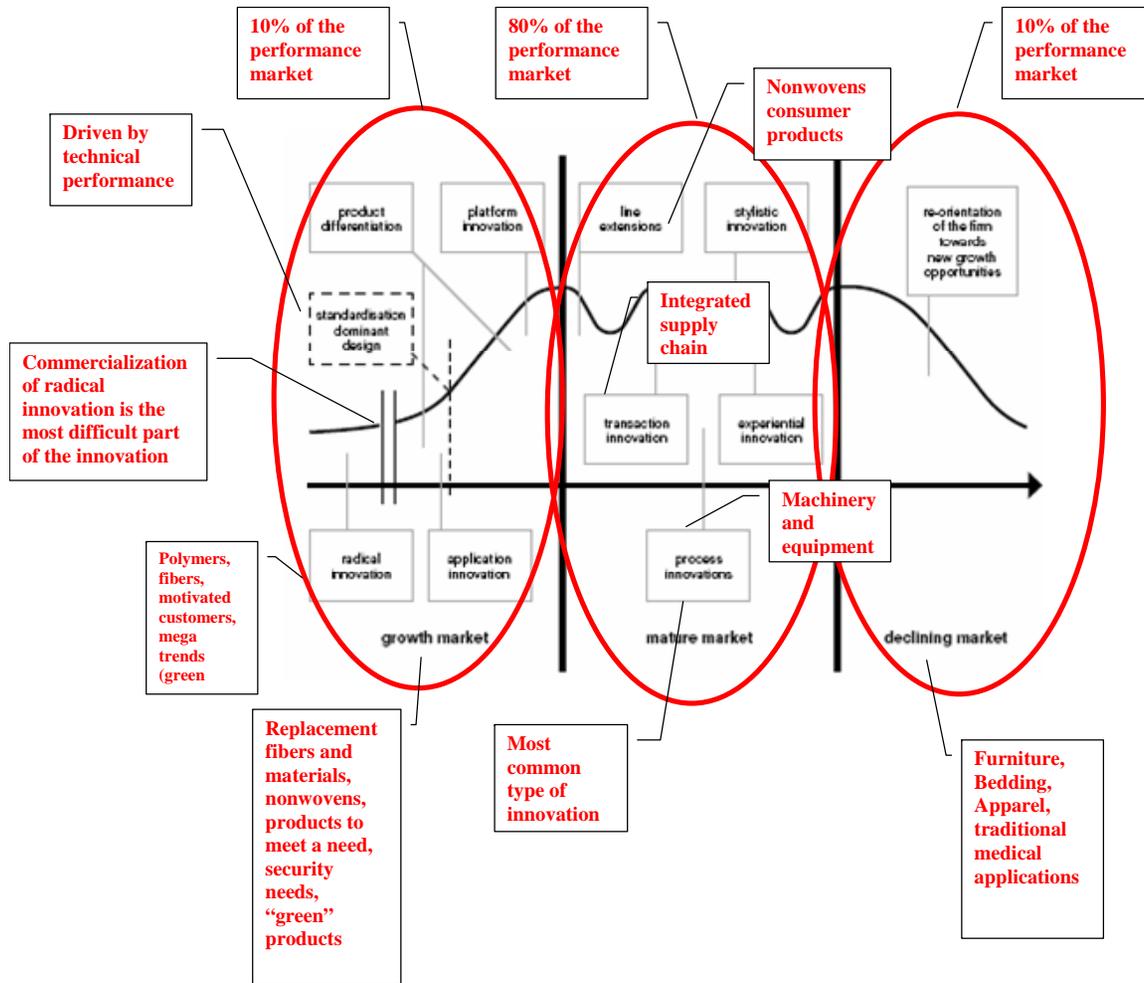
Focus group data validated the applicability of the Lifecycle of Innovation to the performance textile market. Throughout focus group discussions participants discussed varying product categories that were at differing stages in the Lifecycle of Innovation model.

Focus group discussions validated that radical innovations do not occur regularly (Jacob's 2007). In terms of performance textiles, radical innovations occur in polymer and fiber developments, motivated customers, and mega trends such as the green movement. Companies that can anticipate mega trends have the ability to innovate radically. Commercialization and bringing products to market are the most difficult stages of the innovation process for performance textiles. This finding also validates Jacob's theory and is represented by parallel lines on the model. Standardization of design is determined by industry standards according to focus group data. Growth markets include replacement fibers and materials, nonwovens, green products, and products to meet customer's needs. Line extensions, transaction innovations, and process innovations are the most common types of innovation according to Jacob's (2007). Focus group discussions validated that these types of innovations are innovation drivers in their markets. Nonwoven consumer products, machinery investments, and integrated supply chains are examples from focus group discussions in terms of these types of innovations. Jacob's describes declining markets as those that are in need of renewal. Focus group respondents confirmed this theory and categorized (locally made) textile declining markets as: furniture, bedding, apparel, and traditional medical tools. Focus group participants determined that 80% of the performance textile market is placed in the mature market phase, while 10% of the market is placed in the

growth market phase and the remaining 10% of the market is placed in the declining market phase.

Figure 32 aggregates focus group data and plots the findings on the Lifecycle of Innovation.

Figure 32 Innovation Findings for North Carolina Performance Textile Market



Source: Nelson adapted from Jacobs, D. (2007). *Adding Values*. Rotterdam: Veenam Publishers and ArtEZ Press.

Textile Added Value Curve

Previous research (2006) indicated that value is most often added in the pre and post production process of the textile complex. The figure depicts today's dynamics of the global textile business illustrating the "value-added" operations in the pre-production and post-production stages with lower "value-added" in manufacturing operations (Cassill et al, 2006). Phase II focus group data validated this theory, but also provided viable insight into value added activities at the manufacturing level, thus raising the manufacturing curve.

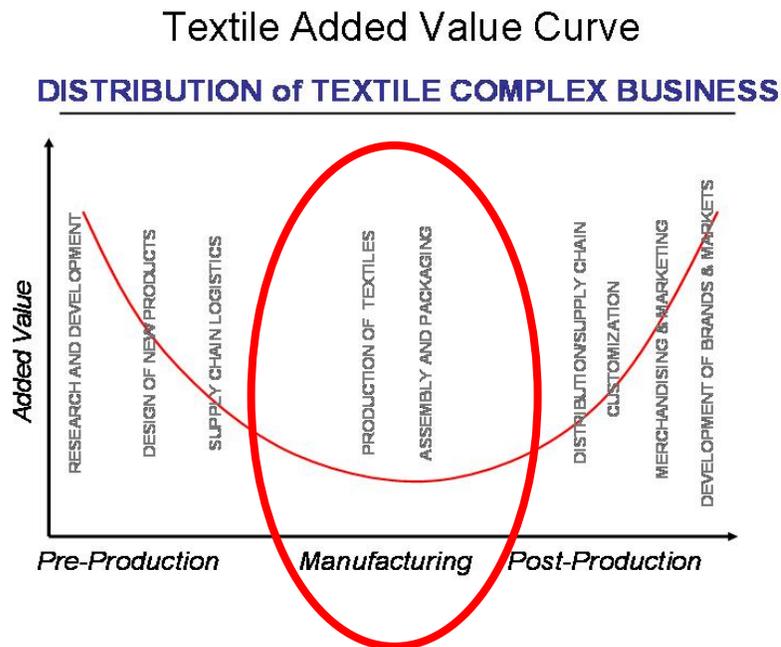


Figure 33 Textile Added Value Curve

Source: Cassill, N.; Godfrey, B., & Little, T. (2006). "The New World of Textiles", white paper, NC State College of Textiles Strategic Planning Session, Raleigh, North Carolina.

DISTRIBUTION of TEXTILE COMPLEX BUSINESS

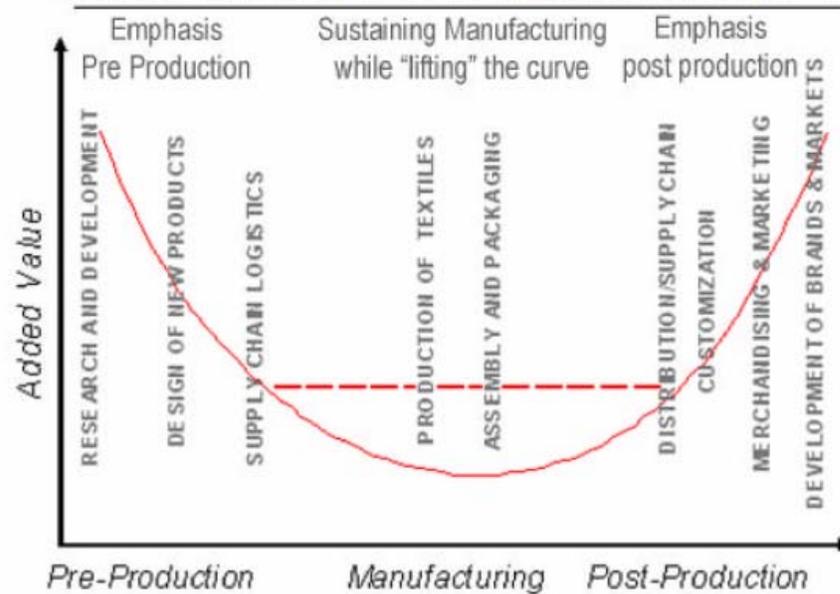


Figure 34 Lifting the Curve

Source: Cassill, N.; Godfrey, B., & Little, T. (2006). "The New World of Textiles", white paper, NC State College of Textiles Strategic Planning Session, Raleigh, North Carolina.

Strategies discussed at Phase II focus groups for raising the manufacturing curve specific to the North Carolina performance textile industry included:

- Machinery innovations, adaptations, and refinement
- New equipment, investments in implementing new production lines
- Development of more efficient and economical conversion methods
- Flexibility in manufacturing, running several products at once
- Adding coatings and specialty finishes in the manufacturing/production process
- Improvements in fiber production

- Innovating production processes allows for changes in the characteristics and dynamics of fibers and products thus creating new end products
- Workforce attraction through marketing the importance of manufacturing in the textile complex.

The NC State College of Textiles can aid in the “lifting” of the manufacturing curve. The College has expertise in manufacturing, research and development, markets/marketing, supply chains and has facilities to accomplish this opportunity (Cassill et al, 2006).

CHAPTER V
CONCLUSIONS, IMPLICATION, LIMITATIONS, AND
RECOMMENDATIONS

Summary

The purpose of this research study was to conduct an analysis of the performance textile industry in North Carolina and provide the foundation for building a “performance cluster” in North Carolina. Another purpose of this research was to analyze factors that contribute to or hinder competitiveness in the textile and apparel industry in terms of performance textile applications. The performance textile sector provides competitive, value added market opportunities. In addition to performance textile markets providing competitive advantage, innovative and value added product and process opportunities are achieved through performance applications. Globally, technical textiles are considered to be the fastest growing sector of the textile market (Shisoo, 2004). Performance textiles are 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). Since performance textiles impact economic and social activity (Horrocks & Anand, 2000) performance textiles can provide North Carolina textile and apparel companies with production and market opportunities for differentiated products. This research sought to holistically analyze and profile the North Carolina performance textile complex.

The conceptual models used in this study provided a framework for applying innovation in products and processes. Innovation is a market driver in terms of performance

textiles. The models examined were 1) Jacob's Lifecycle of Innovation (Jacobs, 2007), and 2) the Textile Added Value Curve (Cassill et al, 2006). Both models are used to examine innovation and added value in terms of product categories, pre production, manufacturing, and post production processes. The Lifecycle of Innovation model is specific to product categories, not single products which are most often plotted on lifecycle diagrams. Product categories may experience decline at some point, but due to renewal (innovation) they can be revived (Jacobs, 2007). The Textile Added Value Curve provides a framework for processes related to providing differentiated products undeterred by cost pressures and competition. Both models provide a method for regaining competitive advantage through innovation and added value.

The methodology used in this study used a two phase approach to address the research objectives of this study. Phase I included an analysis of the global performance textile industry in addition to the performance textile industry specific to North Carolina. Phase I identified the performance textile industry in North Carolina through geographic clusters. Each phase consisted of a focus group for data collection (qualitative). The instrument utilized for each focus group was developed by the researcher. Topics of interest for the Phase I focus group included: industry requirements cluster formation, trade and expertise, and information needed for competitiveness. The sample used in Phase I focus groups was 53 companies. The response rate was 56 percent.

Phase II provided an analysis of growth opportunities and competitiveness issues specific to the North Carolina performance textile complex. Phase II validated the geographic cluster structure of four opportunistic performance sectors; protective, medical, industrial and

construction. Phase II focus groups contained the following sections: global competitiveness, growth potential, market trends, innovation, added value, advanced manufacturing, quality, standards, technical performance, and industry needs. Phase II focus groups were divided into narrowed, market segments in order to obtain detailed sector information. The protective focus group had a sample size of 12 with a 34 percent response rate. The medical focus group had a sample size of 11 with a 26 percent response rate. The sample size for the industrial focus group was 7 and the response rate was 21 percent. The sample size for the construction focus group was 8 and the response rate was 32 percent.

Summary of Results

1. To analyze the global performance textile industry including product and market dynamics, shifts in marketing strategies, and industry characteristics using secondary sources.

Globally, technical textiles are considered to be the fastest growing sector of the textile market (Shisoo, 2004). Performance textiles are 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).

2. To analyze the North Carolina performance textile industry by providing a profile of the performance textile industry using secondary and primary sources.

North Carolina has approximately 517 companies competing in the performance textile industry. Of these 517 companies, 148 compete in multiple performance textile sub-sectors in

North Carolina. Eleven percent of the companies competing in the performance textile industry in North Carolina are publicly held and 89% percent of the performance textile companies are privately held. Collectively performance clusters provide an estimated \$18,094,043,464 in annual sales. There are approximately 60,000 employees working in the performance textile industry in North Carolina.

3. To identify North Carolina companies competing in the performance textile industry using appropriate sub-sector definitions.

Currently all 12 performance textile sub-sectors exist in North Carolina. The industrial, transportation, apparel, protection, and medical sectors have the largest presence in the state in terms of company locations. Industrial, medical, and protection rank the highest among sub-sectors in terms of estimated annual sales.

4. To identify the cluster structure and dynamics of performance textile companies.

The North Carolina performance industry is represented in 76 out of 100 counties. 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.

5. To conduct a focus group for validation of industry requirements, cluster formation, trade and expertise, information needed for competitiveness.

Phase I focus groups discussed present and future challenges and opportunities for the state's performance textile industry. The focus group served as an opportunity to bring together industry, government, and academic personnel to discuss current and future challenges and opportunities. The focus groups uncovered three themes: industry standards,

innovation, and communication. Key issues discussed at the meeting included:

1. Industry standards- Standards issues included the difficulties related to competing, differentiating, and selling performance textile products because industry standards have not been established. It was determined that such standards must be established, as most standards related to social, ethical, and environmental responsibilities.
2. Innovation and value-Research and new product development are very important to the industry. Performance textiles require a longer time to market than traditional textiles both for design to market launch and for revenue generation. Market value and performance benefits must be communicated to consumers.
3. Communication-Communication and networking throughout the supply chain, and increasing public and global industry awareness of what North Carolina and the Southeast have to offer in the way of performance textile resources and products. There is a need for a neutral venue for meeting, and sharing, and housing knowledge and information resources.

6. To identify and validate opportunistic sub-sectors for further analyses using quantitative and qualitative criteria.

Average weights for qualitative and quantitative data were combined to determine the top five sub-sectors for further identification and validation in Phase II. The most opportunistic sub-sectors for further development were:

- Industrial
- Construction
- Medical

- Protection (Military)

7. To conduct focus groups with each of the identified growth sub-sectors to determine global competitiveness, growth potential, market trends, innovation, added value, advanced manufacturing, quality, standards and technical performance and industry needs.

Phase II focus groups indicated and further validated the significant presence of the performance textile industry in North Carolina. Additionally, there is a significant interest in growing the performance textile cluster. In order to achieve sustained growth in terms of the performance textile industry in North Carolina, there are five general needs that must be addressed:

1. Increased innovation communication (Innovation partnerships with academia, commerce, industry, and entrepreneurs).
2. Commercialization assistance (Assistance in bringing innovations, new products, and technologies to market).
3. Workforce recruitment, retainment, and development (Attract workers to the performance textile industry).
4. Increased promotion of www.nctextileconnect.com and the availability of statewide networking sessions for business partnerships, development, and supply chain needs.
5. Development of a more attractive business environment in North Carolina.

8. To validate the cluster structure and company placement of growth sub-sectors.

Updated statistics and cluster dispersion was provided for the protection (military), medical, industrial, and geotextile sectors. The geotextile, construction, and agricultural

performance textiles sectors have been combined; thus creating a more dynamic sector as well as one with greater economic impact and scale. An increased presence in terms of company locations, counties participating, sales, and employment was identified for each opportunistic sub-sector thus validating the growing presence of the performance textile industry in North Carolina.

9: To refine the variables for adding value and address the dynamics in terms of performance textiles related to the Textile Added Value Curve and Jacob's (2007) Lifecycle of Innovation.

Focus group data validated the applicability of the Lifecycle of Innovation to the performance textile market.). Phase II focus group data validated the Textile Added Value curve in that added value is most often achieved in pre and post production processes. Phase II focus groups also provided viable insight into value added activities at the manufacturing level, thus raising the manufacturing curve.

Limitations

There are five limitations to the research study.

1) Definition of industry

The performance textile industry is not well defined and limited research exists about the industry. Various handbooks, academic journals, and industry leaders define the industry quite differently. No two published sources, industry bodies or organizations ever seem to adopt precisely the same approach when it comes to describing and categorizing specific products and applications of performance textiles (Horrocks & Anand, 2000). In addition, the statistical definitions that are used to measure the textile industry are based on

traditional classification. The definitions within both the SIC and NAICS systems focus on broad activities or product categories. Many performance products are not specifically identified in official data but are typically classified according to fiber, yarn content, and process (Woon, 2002).

2) *Definition of end market*

A secondary limitation of the research project relates to defining end markets and quantifying their market share. Performance textile sub-sectors have many overlaps, often use the same raw material, and pass through similar levels of processing and manufacturing. Thus, it is difficult to strictly define products and determine sub-sector affiliation.

3) *North Carolina Textile Complex Database*

The third limitation of the research project relates to the use of the North Carolina Textile Complex Database. As discussed in the 2006 research project, the North Carolina Textile Complex Database has four limitations:

- a) Some companies that are involved in the textile business may be reporting diverse (non traditional textile) NAICS, and have not been included in the database. Known under-represented companies include
 - a. Consumer product companies (e.g., Proctor & Gamble)
 - b. Medical textile companies
 - c. Uniform (including military and image apparel)
 - d. Service industries and auxiliary firms supporting the textile complex.
- b) The database captures a point in time and may not represent daily business dynamics

- (growth, entering or exiting the textile industry).
- c) With 91% of companies represented in the database being privately held, limited information was obtained by many of the private companies (due, in part, to fewer reporting requirements of private companies vs. public companies). While the researchers are familiar with many North Carolina companies, proprietary information is based on estimates provided in secondary literature. All markets may not be represented due to the private nature of information available.
 - d) Sales data are represented in the database is incomplete, due to the proprietary nature of private companies (Cassill et al, 2006).
4. A convenience sample of North Carolina companies was used for both Phase I and Phase II. Companies participating in this study were identified by the researcher and NC State College of Textiles personnel.
5. Phase II was limited to a manageable number of identified growth sub-sectors for further explanation.

Recommendations

- 1) Future research could focus on continued refinement of company placement among performance textile sub-sectors.
- 2) It was found during research that companies need increased innovation communication in order to stay ahead of market trends. Future research could determine the best method for dissipating such information and determine the level of information needed for competitiveness.
- 3) Future research could focus on further understanding the commercialization process

- of new products and technologies. North Carolina companies need assistance in the commercialization of products and further research could provide a better understanding of this process.
- 4) It was found during research that in order for North Carolina companies to continue to be successful and viable in the performance textile industry, workforce development is needed. Future research could consist of further understanding the types of employees that are needed in the performance textile industry, their skill level, and ways in which to attract these types of employees.
 - 5) A new network in terms of the North Carolina textile industry is needed. As companies continue to change and restructure in order to be competitive, an increased promotion of www.nctextileconnect.com is needed. Industry, academia, government, and entrepreneurs need to be trained to use this website as a means for connecting supply chains, finding materials, developing relationships, and creating business opportunities. Future research could provide the information needed for this type of training and the best way to deliver training materials.
 - 6) Other opportunistic clusters exist in North Carolina as identified by Cassill (2006). Future research could provide a better understanding of the dynamics associated with these clusters by following a similar methodology to this research.
 - 7) Focus group findings indicated the need for seminars devoted to current topics in the performance textile industry. Suggested seminar topics included: commercialization processes, new technologies and developments in fibers, polymer, and materials, entrance in to foreign markets, export opportunities, working with governing and

testing bodies, the Berry Amendment, understanding the green movement, marketing/branding new innovations, understanding legislation, and supply chain connectivity.

- 8) Strategic military meetings are needed as found during the research. Topics and speakers should include: procurement leaders, Berry Amendment experts, export assistance in terms of allied military markets, specification development assistance, technical reports on new, global innovations, and standards.

References

- Allen, R. (2006). *Increasing the economic competitiveness of the U.S. textile industry: An investigation of niche strategies*. Unpublished M.S., North Carolina State University.
- Berdine, M. (2007). *Measuring Productivity through competitive advantage*. Unpublished MS thesis. North Carolina State University.
- Burgelman, R. A., Christensen, C. M., & Wheelwright, S. C. (2004). *Strategic management of technology and innovation*. New York, NY: McGraw Hill/Irwin.
- Cassill, N.; Godfrey, B., & Little, T. (2006). "The New World of Textiles", white paper, NC State College of Textiles Strategic Planning Session, Raleigh, North Carolina.
- Cassill, N., Godfrey, B., Little, T., & Frederick, S. (2006). State of the Union of the Textile Industry in North Carolina: Improving Global Market Competitiveness with Identification and Assistance of Core Competencies.1-68.
- Cassill, N., Godfrey, B., Little, T., Frederick, S, Sampson, L. (2007). State of the Union of the Textile Industry in South Carolina: Improving Global Market Competitiveness with Identification and Assistance of Core Competencies.
- Cassill, N., Proposal: Building the Performance Cluster in North Carolina: Providing Assistance to Enhance Global Market Competitiveness of the North Carolina Textile Industry. , 2006.
- Cassill, Nancy. (2006) Chapters 1-9 Power Point Slides. Marketing Research, An Applied Orientation, TTM 585, Fall 2006, NC State University.
- Chang, W. & Kilduff, P. (2002). The US market for technical textiles. Small Business and Technology Development Center Technical Textiles Industry Study, 1-32.
- Chi, T., Kilduff, P., & Dyer, C. (2005). An Assessment of US Comparative Advantage in Technical Textiles from a Trade Perspective. *Journal of Industrial Textiles*, 35(1), 153-168.
- Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, Ca: Sage Publications, Inc.
- DeWitt, T. D., Giuipero, L., & Melton, H. (2006). Clusters and Supply Chain Management: The Amish Experience. *International Journal of Physical Distribution and Logistics Management*, 36(4), 289-308.

- DiLuna, Kristie L. An Analysis of the Decision Makers and Decision Making Process for Corporate Image Apparel Purchases. Raleigh, NC: North Carolina State University, 2003. Unpublished Masters Thesis. <http://www.lib.NC State .edu/theses/available/etd-03242003-155900/>
- Frederick, S., Cassill, N., Godfrey, B., & Little, T. (2007). A Descriptive Analysis of the North Carolina Textile Complex: 2006. *Journal of Textile and Apparel, Technology and Management*, 5(4), 1-14.
- Grasso, V. B. (2005). The Berry Amendment: Requiring Defense Procurement To Come From Domestic Sources. *CRS Report for Congress*
- Horrocks, A., & Anand, S. (2000). *Handbook of Technical Textiles*. Cambridge England: CRC Press.
- Jacobs, D. (2007). *Adding Values*. Rotterdam: Veenam Publishers and ArtEZ Press.
- Kaufmann, J. & Krosner, S. (2003). Opportunities Abound for Technical Textiles. *Textile World*, , 31-34.
- Kim, C. W. & Mauborgne, R. (1997). Value innovation: The strategic logic of high growth. *Harvard Business Review*,25-55.
- Kusterbeck, S. (2005). Defense Contractors on Risky Rollercoaster. *Apparel Magazine*, 46(11), 20-43.
- Malhotra, N. K. (1993). *Marketing Research, An Applied Orientation*. Upper Saddle River, New Jersey: Pearson Education, Inc.
- Morris, D., & Wagneur, C. (2007). *World Markets for Technical Textiles to 2012*. Worcestershire, UK: International Newsletters LTD.
- North Carolina Business Center. (2006). *Clothing and Textiles*. Retrieved Sep. 16, 2006, from <http://www.ncmbc.us/CothingandTextiles.php>
- Oh, H. & Suh, M. W. (2003). What is happening to the US textile industry? Reflections on NAFTA and US corporate strategies. *Journal of Fashion Marketing and Management*, 7(2), 119-137.
- Parrish, E (2003). *Niche market opportunities in the global marketplace*. Unpublished dissertation. North Carolina State University.
- Pei, J. (2000). Demand Remains Strong, Rentals Gain Momentum. *Purchasing*, 128(3), 90-92.

- Plunkett Research, Ltd. (2007). *Plunkett's Apparel, Textile, and Fashions Industry Research Center*. Retrieved Sep. 17, 2007, from <http://www.plunkettresearchonline.com>
- Porter, M. (1998). *On Competition*. *Harvard Business Review Books*, 44 (4), 841. Harvard Business School Press.
- Porter, M. D. (2000). Location, Competition, and Economic Development: Local Clusters in a Global Economy. *Economic Development Quarterly*, 14(1), 15-20.
- Porter, M. (1998). Clusters and the New Economics of Competition. *Harvard Business Review*, 76(6), 77-90.
- Rigby, D. (2002). *Technical Textiles and Industrial Nonwovens: World Market Forecasts to 2010*. Manchester: David Rigby Associates Limited.
- Smith, W. C., Isaacs, M., McCurry, J. W., & Rozelle, W. N. (1998). Industrials: Opportunities to Consider. *Textile World*, 148(2), 28-31.
- St. Louis, D. (2006). *Rural Industry Cluster Compendium*. Retrieved Nov. 15, 2006, from http://www.rtsinc.org/rc/hosiery_nc.pdf
- South Carolina Council on Competitiveness. (2006). *New Carolina*. Retrieved Nov. 10, 2006, from <http://newcarolina.org>
- Technical Textiles International, January/February 2003, *Getting started in technical textiles-the secrets revealed*, pages 29-33.
- Technical Textiles International, January/February 2002, *How to transform your business to technical textiles*, pages 19-20
- Technical Textiles International, June 2004. *How to Enter the Technical Textiles Market-the Next Step*, pages 15-25
- Technical Textiles International, June 2004. *Transforming a business for the technical textiles market*, pages 11-13
- Technical Textiles International, March/April 2006, *Need to innovate is key theme at latest How to Enter...event*, pages 11-13
- Technical Textiles International, April/May 2007, *Transforming a business for long-term success*, pages 23-31
- Technical Textiles International, May 2004, *Glen Raven's history proves the power of metamorphosis*, pages 9-13

Technopak, . (2007). Strategies for Textile and Apparel Manufacturers in the Post-Quota Era: Prospects to 2015. *Textile Outlook International*, 3, 152-162.

TX Special Report, . (2005). Specialty Fabrics. *Textile World*, 155(8), 38-39.

Von Hofe, R. & Chen, K. (2006). Whither or Not Industrial Clusters: Conclusions or Confusions. *The Industrial Geographer*, 4(1), 2-28.

Ward, D. (2006). The Evolution of Performance Apparel. *Wearable Business*, 10(1), 61.

Wheelen, T. L., & Hunger, J. D. (2006). *Concepts in strategic management and business policy*. Upper Saddle River, New Jersey: Pearson Education, Inc.

Woon, Chang. An Analysis of US Technical and Industrial Textile Industry, Raleigh, NC: North Carolina State University, 2002. Unpublished Masters Thesis.
<http://www.lib.NC State .edu/theses/available/etd-11222002-153849/>

Personal Interviews:

American and Efird, North Carolina Textile Company, October 31, 2006, Performance textile products and opportunities

Assyst Bullmer, North Carolina Textile Company, October 31, 2006, Performance textile products and opportunities

Automated Solutions, North Carolina Textile Company, October 31, 2006, Performance textile products and opportunities

Cal Poly Pomona (Peter Kilduff, Chair Apparel Merchandising and Management Department), November 1, 2006, Performance textiles in North Carolina

Carolina Narrow Fabric, North Carolina Textile Company, November 1, 2006, Performance textile products and opportunities

Clariant Corporation, North Carolina Textile Company, October 31, 2006, Performance textile products and opportunities

COATS, North Carolina Textile Company, October 31, 2006, Performance textile products and opportunities

Eastern Metal Supply Co, North Carolina Textile Company, November 1, 2006, Performance textile products and opportunities

Firestone Fibers and Textile Company, North Carolina Textile Company, October 31, 2006, Performance textile products and opportunities

FOX, North Carolina Textile Company, November 1, 2006, Performance textile products and opportunities

Glen Raven, North Carolina Textile Company, November 1, 2006, Performance textile products and opportunities

Invista, North Carolina Textile Company, November 1, 2006, Performance textile products and opportunities

North Carolina Department of Commerce (Tammy Lester, Economist), October 4, 2006, Research Project Objectives

President of the Fiber Economics Bureau (Frank Horn), November 1, 2006, State of the Manufactured Fiber Industry

Shuford Mills, North Carolina Textile Company, October 31, 2006, Performance textile products and opportunities

Appendix A: Phase I Focus Group

Appendix A1:Agenda

Agenda
Performance Textiles Focus Group
NC State College of Textiles
Thursday, June 7, 2007
10:00 – 1:30 p.m.
Convocation Center – College of Textiles
Building the Performance Cluster in North Carolina
NC State Professors: Nancy Cassill, Blanton Godfrey, Trevor Little
Research Assistant: Holli Nelson

Focus Group Moderator: John Anderson
Director of the Textile Technology Center at Gaston College
Former Vice President of Marketing and New Products at Wellman

10:00-10:15	Welcome to NC State 's College of Textiles	Blan Godfrey, Dean
10:15-10:30	“Building the Performance Cluster in North Carolina: Providing Assistance to Enhance Global Market Competitiveness of the North Carolina Textile Industry”	Nancy Cassill, Holli Nelson
10:30-10:45	Introduction of Participants	Trevor Little
10:45-11:45	Focus Group Discussion (Part I) Questions: Industry Requirements and Cluster Formation	John Anderson, Moderator
11:45-12:30	Lunch with Topic Discussions	
12:30-1:15	Focus Group Discussion (Part II) Questions: Trade & Expertise and Information & Knowledge	John Anderson, Moderator
1:15-1:30	Summary: Today's Discussion Next Steps	Nancy Cassill Blan Godfrey Trevor Little Holli Nelson

Appendix A2: Focus Group Questions

Topics and Questions for Discussion

Focus Group: *Building the Performance Cluster in North Carolina*

NC State College of Textiles (Convocation Center)

Thursday June 7, 2007 10:00 – 1:30

1. Industry Requirements

- **Supply chain dynamics, new product development, trade, and market analyses**
- What are industry requirements for competing in the technical textile sector? (may be specific to the company and its' end product)
- Is there less competition in this sector? Is it a sector based on price competition or quality competition?
- What are the supply chain dynamics for the technical textile industry? Are they different than those of a traditional textile?
- What are the barriers to entry for the technical textile sector? How can a company overcome these barriers to entry?
- What factors are most important for competing in this sector? (speed to market, quick turn around, replenishment, etc)
- Which supply chain linkages are most important? How influential are these linkages to end product satisfaction?
- Do you work directly/indirectly with all supply chain linkages?
- Companies that are entering the technical textile market are using three methods. Which methods are used by companies in NC?
 - New business start-ups, involving entrepreneurs who perceive new market opportunities or who have developed new product technologies and obtain financial backing.
 - Diversification of established textile companies into technical markets through internal development or acquisition as markets in consumer products are lost.
 - The entry of foreign technical textile companies into the US market through acquisitions or green field investment.

2. Cluster Formation

- **Geographic and virtual**
- Would a cluster model relevant to the technical textile supply chain provide NC companies with a competitive advantage?
- Does NC have the infrastructure to build the technical cluster? Is the state lacking in certain key areas?
- Which supporting industries are most vital in the development of a company's technical textile infrastructure?

- What is your company's greatest need? (Data, product testing, shared resources)
- What are the best methods for providing this data?

3. Trade and Expertise

- How is new product development different than that of a traditional textile product?
- Are trade regulations different or stricter for technical textile products and components? Is sourcing an issue for this sector? Is there a struggle to find low cost, quality technical textile components overseas?
- What is your company's present sourcing model?

4. Information/knowledge needed for competitiveness (strategies, tactics)

- Can the Berry Amendment and the increase in military demands enhance the profitability of companies competing in the technical textile sector?
- Comment on the 13 technical sub-sectors. Is NC competing in all? Which provide growth opportunities? Where is the state lacking?
- Are there other areas of technical textiles not represented in these sectors?

Appendix A3: Moderator Biography

John Anderson, Focus Group Moderator

John Anderson is the Director of the East Campus and Textile Technology Center at Gaston College. John joined the Center in November of 2006, after a brief flirtation with retirement. John spent 38 years marketing synthetic fiber with Celanese, Hoechst-Celanese, and Wellman, Inc. He retired from the position of Vice-President, New Products in March of 2006.

He holds an MBA in Marketing from New York University (The Stern School), a BA in Economics from Gettysburg College and is a graduate of the Program for Management Development at Harvard Business School. He also taught Fashion Merchandising at Fashion Institute of Technology as an adjunct faculty member.

John resides in Waxhaw, NC and also writes a weekly column for the Charlotte Observer

Appendix A4: Invitation Letter/Email

May 5, 2007

Dear xxxx:

North Carolina State University's College of Textiles is conducting a study that focuses on performance textiles. Performance textiles are materials and products manufactured primarily for their technical and performance properties in addition to their aesthetic or decorative characteristics. Various end uses for performance textiles are technical applications, apparel, home textiles, medical, military, nonwovens, and transportation.

The aim of this study, funded by the North Carolina Department of Commerce, is to determine key ways to assist North Carolina textile companies producing and marketing these products in achieving *global market competitiveness*.

Because of xxx's importance to North Carolina in the production and/or marketing of performance textiles, we would like to invite you to the NC State College of Textiles to participate in a focus group **Thursday, June 7, 2007, #3436 Textiles, 10:00 am until 1:30 pm** (*lunch will be provided*). Mr. John Anderson, Director of the Textile Technology Center at Gaston College and formerly Vice President of Marketing and New Products at Wellman, will act as moderator of the performance focus group.

Focus group topics will include supply chain dynamics and opportunities, cluster strategies, product and market innovation, information needed for competitiveness and the opportunity for North Carolina to serve as a center of knowledge, in addition to relevant performance textile topics. Outcomes of this session will include strategic initiatives that can assist the North Carolina textile industry, as well as individual companies, in global competitiveness.

A key benefit for your company's focus group participation is the interaction with other North Carolina textile industry executives during the session, as well as access to the study's findings once completed July 2007. By participating in the focus group, your company will have the ability to identify issues that impede competitiveness and formulate ways to remove or improve these issues.

We hope that you will consider participating in this focus group and if you are unable to be with us, please recommend someone from your company to participate. It is important to have xxx's participation and we hope that you will have the opportunity to be represented in this important industry discussion.

Please confirm your company's participation with identification of company representative via email by Friday, 25th 2007. All confirmations should be directed to Holli Nelson, hgnelson@ncsu.edu. A letter will follow soon, in addition to logistics that will be provided by May 31st.

Thank you for your time and consideration in participating in this study. We look forward to seeing you on June 7, 2007.

Regards,

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

Appendix A5: Logistics Email

Subject: NC State College of Textiles Focus Group-Logistics

Thank you for agreeing to participate in the focus group, Building the Performance Cluster in North Carolina, Thursday, June 7, 2007, 10:30 - 1:30, NC State College of Textiles, Convocation Center. This focus group is part of a research study funded by the North Carolina Department of Commerce, and the aim is to determine key ways to assist North Carolina textile companies producing and marketing these products in building/maintaining global market competitiveness.

The focus group moderator, Mr. John Anderson, will guide the discussion, with textile-related topics including supply chain dynamics and opportunities, cluster strategies, product and market innovation, information needed for competitiveness, and the opportunity for North Carolina to serve as a center of knowledge. Outcomes of this session will include strategic initiatives that can assist the North Carolina textile industry, as well as individual companies, in global competitiveness--- as well as the identification of key roles that the NC State College of Textiles can play to assist the North Carolina textile complex.

A key benefit for your company's focus group participation is the interaction with other North Carolina textile industry executives during the session, as well as access to the study's findings once completed July 2007.

The focus group will begin promptly at 10:00 a.m. Directions to the College can be found at: <http://www.tx.ncsu.edu/college/directions.pdf>. You will need to secure a parking permit at the Visitor Center as you enter Centennial campus. Parking is available in the Textile Visitor parking lot, as well as other locations, as identified by the Visitor Center attendant.

Attached you will find an attendee list, focus group topics and questions to be discussed, and the meeting's agenda. If you have any further questions or concerns, please contact Holli Nelson, hgnelson@ncsu.edu.

Also, if you have any questions or problems on June 7th, please call Holli at 336-880-5088.

Thank you in advance for your participation -- we look forward to seeing you next Thursday!

Regards,
Holli Nelson

Appendix A6: Participant Listing, Company, Name, Email

Name	Company	Email
Peggy Pickett	AATCC	pickettp@aatcc.org
Perry Grady	AATCC	gradyp@aatcc.org>
Tony Webber	Adaptive Control	tony.webber@adaptivecontrol.com
Mark Hatton	American and fford	Mark.Hatton@amefird.com
Jim Morelli	American Fibers and Yarns	
Tracey Campbell	American Fibers and Yarns	twcampbell@afyarns.com
Stephanie Norris	ATEX Technologies	StephanieNorris@atextechnologies.com
Robert Daniel	Basofil	bobdaniel@basofil.com
Frank Bell	Bell Associates	fbell@nc.rr.com
Alex Whitley	Contempora Fabrics	awhitley@contemporafabrics.com
Bill Rearick	Cotton Inc	BRearick@cottoninc.com
Gary Raines	Cotton Inc	GRaines@cottoninc.com
Janet O'Reagan	Cotton Inc	joregan@cottoninc.com
Bill Hunneke	Domestic Fabrics	BillH@domesticfabrics.com
Fred Hunneke	Domestic Fabrics	
Uli Marker	Domestic Fabrics	
Felipe A Ramirez	DSM	Felipe.Ramirez@dsm.com
Jose Merino	Duke Energy	
Steven Sheek	Duke Energy	SLSheek@duke-energy.com
Hal Bates	Glen Raven	bateh@glenraven.com
Gordon Magee	Goulston Technologies	GMagee@goulston.com
Sally Kay	Hosiery Association	sally.kay@hosieryassociation.com
Dan St. Louis	Hosiery Technology Center	sockman@legsource.com
Mike Cheek	Huntsman International	mike_cheek@huntsman.com
George Edmunds	Institute of Textiles Technology	gcedmund@NC State .edu
Bill DiIanni	ITG	Bill.DiIanni@itg-global.com
John Anderson	Moderator, Textile Technology Center Gaston College	Anderson.John@gaston.edu
Jim Booterbaugh	National Spinning	jimb@natspin.com
Ken Sigmon	National Textile Foundation	
Danielle Seale	NC DOC	
Holly Crosby	NC DOC	
Michelle Atkinson	NC DOC	
Tammy Lester	NC DOC	tlester@nccommerce.com
Teresa Bouchnett	NCMBC	bouchonnett@ncmbc.us
Blan Godfrey	NC State	blanton_godfrey@ncsu.edu
Emily Parker	NC State	emily_parker@ncsu.edu
Erin Powell	NC State	erin_powell@ncsu.edu
Holli Nelson	NC State	hgnelson@ncsu.edu

James Spratley	NC State	jesprat@earthlink.net
Nancy Cassill	NC State	nlcassil@ncsu.edu
Robert Crew	NC State	RCrewsNest@aol.com
Roger Barker	NC State	roger_barker@ncsu.edu
Stacey Frederick	NC State	sfreder@ncsu.edu
Trevor Little	NC State	tlittle@ncsu.edu
Manfred Wentz	Oeko Tex	mwentz@nc.rr.com
Doug Woolweaver	Parkdale	dougwoolweaver@parkdalemills.com
Harold Edwards	Pharr Yarns	Harold.Edwards@pharryarns.com
Terry Montgomery	Precision Fabrics Group	Terry.Montgomery@precisionfabrics.com
Jeff Bruner	Quantum Group	jbruner@quantum5280.com
John Wilson	Quantum Group	jtuu@msn.com
Kim Hall	RadiciSpandex	khall@radicispandex.com
CP Davis	Shuford Mills	cpdavis@shurtape.com
Mike Carter	Spectrum Dyed Yarns	Mike.Carter@sdyc.com
Derek Gunn	Unifi	DGunn@UNIFI.COM
Jermaine Holloway	Unifi	

Appendix A7: Thank You Email

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 Performance Cluster in North Carolina*.

Attached is an executive summary of the focus group, an evaluation form, a listing of all participants, and definitions. The definitions are intended to aid in answering the evaluation form.

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.

Thank you,
Holli Nelson

Appendix A8: Focus Group Executive Summary

Executive Summary: Focus Group

Building the Performance Cluster in North Carolina

June 7, 2007

North Carolina State University College of Textiles

North Carolina State University's College of Textiles held the inaugural focus group dedicated towards developing a performance textile cluster initiative on June 7, 2007, 10:00 – 1:30 pm., in the College's Convocation Center. North Carolina is the location of many global companies competing in performance textiles. This inaugural focus group was an opportunity to bring together industry, government, and academic personnel to discuss current and and future challenges and opportunities.

A total of 53 participants attended the focus group, representing 34 North Carolina textile-related companies. Participants included industry leaders, consultants, association representatives, NC State faculty and graduate students, and North Carolina Department of Commerce project managers.

The morning session began with a Welcome from Dr. Blanton Godfrey, Dean of the College of Textiles. Dr. Nancy Cassill, Principal Investigator, and Holli Nelson, the research study's graduate student, presented a short PowerPoint presentation discussing the research study's objectives, expected results, and definitions related to performance textiles and sub-sector breakouts. *The underlying theme of the presentation was to identify the specific needs of the performance textile industry in order to enhance global market competitiveness.*

Dr. Trevor Little led participant introductions. Each participant was asked to provide their name, company name, position in company, products or services provided to the industry, and experience level in performance textiles. Representatives of the textile value chain (fiber, yarn, fabric producers, manufacturers, suppliers) were in attendance. John Anderson, Director of East Campus and Textile Technology Center at Gaston College, served as the moderator for the focus group and was introduced by Dr. Cassill. Once all introductions were finished, focus group discussion began.

Questions focused on four distinct areas vital to understanding the performance textile industry and its sub-sectors: Industry requirements, cluster formation, trade and expertise, and information needed for competitiveness. Performance textiles were defined as textile materials and products manufactured primarily for their technical and performance properties in addition to their aesthetic or decorative characteristics. Below are key points discussed at the meeting:

Industry Requirements and Partnerships

- A lack of established industry standards relating to performance textiles can make it difficult to compete, differentiate, and “sell” your product.
- Establishing these standards are critical for competing in this sector and will benefit new product development processes, as well as provide a method for comparing products throughout the supply chain equally.
- Industry requirements also include social, ethical, and environmental responsibilities.

- A method for differentiating is to promote and market that US companies meet these social, ethical and environmental responsibilities.
- Research and new product development are critical to success.
- With “power” existing further downstream, it is imperative for companies to connect with customers. Close partnerships are needed through the supply chain including the retail sector and end-use consumers as well as with non-retail customers. Future focus groups should also include customers (retail, non-retail organizations).

Competition

- Companies must know the competition, including the competitive environment, competing companies, and market dynamics, including opportunities for product differentiation and niche markets.
- Consumers, as well as supply chain linkages, must understand the balance between quality and price.
- Value is often misunderstood by the consumer. There must be a way to market value and performance attributes to consumers (and customers) in a way that they understand and will be willing to pay more for the product.
- Sub-sectors noted which are more price conscious include apparel and medical (institutional). Other types of medical applications and very technical applications are not as price sensitive (as these two sub-sectors) and rely heavily on performance attribute identification and education to the customer.
- Competition is not always associated with inter-industry competition, but often is defined by price.

Traditional Textiles vs. Performance Textiles

- Suppliers must stay current with new technology, and in this industry this is not always the case.
- The design to market launch timeline for performance textiles takes ~ 18 months; this means that a longer timeline (than traditional textiles) is needed to realize revenue for performance textiles vs. traditional textiles.
- To compete in the performance textiles global market, companies must compete backwards and forwards. Companies must make sure suppliers are innovative and understand consumer demands, as well as understand the newest performance technologies.
- Vertically integrated companies can often stay ahead of the curve and are reassured that suppliers are using the newest technology offered.
- Consumers are demanding products with performance attributes. Customers are pulling these products through the supply chain. PUSH and PULL strategies are used. One barrier to entry to performance textiles is *MENTALITY*; this requires companies to approach the performance textile market with diverse strategies (PUSH and PULL).
- Would a performance textile trade show benefit companies in North Carolina? Many

participants discussed this idea and believe this is a possibility. It would be more cost effective, less travel time, and could benefit cluster formation and economic development. The hosting site could be NC State College of Textiles, with coordination by the NC Department of Commerce.

Entrance into the Performance Industry

- All types of market entrance methods were discussed and are used to enter this segment. These include: acquisitions, entrance by foreign companies, and expansion.
- Acquisitions are often used by companies wishing to delve into more niche technical areas.
- Foreign companies enter the market by moving locations to North Carolina because of textile history, infrastructure, and market and supplier accessibility.
- Companies can also enter by evolving out of current existing divisions and companies.

What can NC State College of Textiles and the North Carolina Department of Commerce Do to Assist?

- Companies need a neutral meeting site that can be used for knowledge and information resources.
- With the planned Summer 2007 launch of the *Textile Information Warehouse* (a second research project being completed by NC State College of Textiles -- funded by the NC Department of Commerce), performance textile focus group participants agreed to pilot test this electronic information warehouse prior to the launch.

Note: The beta site of the Textile Information Warehouse was briefly presented to participants during lunch.

- There is a need for a better understanding of technical applications (geotextiles, agricultural, and other sub-sectors) that comprise the performance textile area.
- A performance textiles seminar would be helpful and many participants would attend. This seminar could focus on specific technical products (e.g., geotextiles, medical, industrial, other) as well as new product development, market information and market entry.
- Information is needed on how to attract talent with a technical background and expertise. The College is challenged, with the increased enrollment, in preparing the future leaders for this industry, with both product and market expertise.

Next Steps

- Preliminary “next steps” include:
 - *Focus groups*, segmented by performance application
 - *Educational seminars* related to specific performance textile topics (product, product development, market dynamics, trade, other topics to be identified)
 - *Promotional efforts*, including trade show development.

- Additional focus groups and activities will be held at a neutral place, such as NC State College of Textiles (Raleigh) and/or Duke Energy (Charlotte area). Continued development of activities will be discussed by NC State and NC Department of Commerce personnel, as well as focus group participants (via evaluation forms sent to all participants). These inputs will provide “next step” direction to the NC State researchers.

Appendix A9: Evaluation Form

Building the Performance Cluster in North Carolina

June 7, 2007

Evaluation Form

Please complete the evaluation form with your honest opinions in order for additional focus groups to meet your company’s needs. Thank your for your time and opinions. Pleas email the completed evaluation form to Holli Nelson, hgnelson@ncsu.edu by Monday June 18th.

1. Which topics discussed were most helpful, and why? Which topics discussed were not helpful, and why? Was there a topic not discussed that would having been beneficial to you and your company?
2. Comment on the structure of the focus group. How could it have been improved? For future meetings, how would you advise dividing the group? (by sector involvement, supply chain position, random selection)
3. Discuss the strengths and weaknesses of the focus group.
4. Are you interested in continuing to be involved in this project? We addressed the next steps for the project at the end of the day. These included communication (additional focus groups), education (seminars, knowledge resources), and promotion (trade shows). Which areas are you most interested in?

5. Please discuss additional comments.

Appendix A10: Completed Evaluation Forms

Building the Performance Cluster in North Carolina

June 7, 2007

Evaluation Form

Thank you for your time and participation in the Performance Textile Focus Group, Thursday, June 7, 2007, NC State College of Textiles. Please use this form to provide inputs, suggestions, and “next step” ideas to us. *It is important that this focus group PLUS future activities meet your company’s needs.*

Please e-mail the completed evaluation form to Holli Nelson, hgnelson@ncsue.edu by Monday June 18th.

- 1. TOPICS:** Which topics discussed were most helpful, and why? Which topics discussed were not helpful, and why? Was there a topic not discussed that would have been beneficial to you and your company?

Overall, it was a good beginning. It produced some very good discussions and started people thinking of ways to bring companies together for mutual benefit.

Most helpful was the open discussion led by John Anderson. This segment pointed to the need of specific communications between the potential customer and the supplier. To be able to supply a product we first must understand the requirements of the product required and match that up with a supplier that can meet the requirements.

I felt the topics covered were appropriate for the initial meeting

- 2. FOCUS GROUP COMPOSITION:** Comment on the structure of the focus group. How could it have been improved? For future meetings, how would you advise dividing the group? (by sector involvement, supply chain position, random selection, other)?

Alignment of the full supply chain by market segment would be more effective.

Future focus groups should be held by sectors. Specific communications of suppliers products to potential customers is vital.

As discussed during the meeting, the group size was too large to be as effective as it could be. HOWEVER, it was extremely important and interesting to understand the many different areas of the business that were represented for the first meeting. It is clear that there was a principal focus in Performance apparel based on this group composition. I believe that future groups should be segmented by principal market focus & supply chain position (relative to the end consumer; industrial manufacturing OR retail sales).

3. STRENGTHS AND WEAKNESSES: Discuss the strengths and weaknesses of this focus group.

Strengths – A lot of experience over a wide range of products, markets and processes.

Weakness – Too broad to get into the real details and initiate meaningful progress.

Strengths: strong interest and dedication of the participants. Wide cross section of market segments present. NC STATE faculty and State DOC participation showed a commitment to the participants in this side of the business, and a desire to stable relevant to the NC textile industry.

Weakness: Large size and variety of participants prohibited more specific and detailed discussions relative to individual companies. Too focused on performance apparel. Not enough focus on industrial fabric and industrial yarns/ cord applications. Would like to see more fiber producer involvement.

4. CONTINUED INVOLVEMENT: Are you interested in continuing to be involved in this project? If so, the “next steps” identified by the group included:
a) Additional focus groups, with segmentation by performance textile application; b) education (seminars, knowledge resources); and c) promotion efforts, including trade shows. Which areas are you most interested in participating? Other ideas?

a), b) and c), not trade shows. Our products involve surface modification of synthetic fibers through topically applied lubricant systems and internal polymer additives. Therefore, we would be interested in participating in most forums.

Interested to continue in the focus groups but would request it be by specific sectors. Communications of supply versus customer requirements important.

*Apparel
Home Furnishings
Industrial
Medical
Protection
Sport*

Yes, I would be interested in continuing to be involved. Would be interested in helping to define the segmentation, and being involved in the appropriate focus group relative to A&E's participation.

- 5. ADDITIONAL COMMENTS:** Please share additional comments that you would like to share.

The key to this business from our perspective is R&D and technical developments. Would like to see how companies can source product testing and validation, safely and discreetly. Would also like to determine how to tap NC State resources in emerging technology and demands specific to the segments we participate in.

Appendix A11: Information and Follow Up Focus Group Requests

Company	Contact	Email	Request
ATEX Technologies	Stephanie Norris	stephanienorris@atextechnologies.com	Medical, Bio Materials
Unifi	Derek Gunn	dgunn@unifi-inc.com	Apparel, Home, Protection
Bell Associates International	Frank Bell	fbell@nc.rr.com	Environmental, Transportation, Protection, Military
American & Efired	Mark Hatton	mark.hatton@amefird.com	Home, Industrial, Medical, Transportation, Protection
American Fibers and Yarns Company	Tracey W. Campbell	twcampbell@afyarns.com	Apparel, Home, Medical, Industrial, Military, Transportation, Sport
Domestic Fabrics	William Hunneke	billh@domesticfabrics.com	Nanotechnology, Antimicrobial /Viral Technology, Industrial, Medical, Military
Radici Spandex Corporation	Kim Hall	khall@radicispandex.com	Supply Chain
Spectrum	Mike Carter	mike.carter@sdyc.com	Protection, Transportation, Home Furnishings
DSM Dyneema	Felipe Ramirez	felipe.ramirez@dsm.com	Construction, Geotextiles, Industrial, Medical, Transportation, Protection, Sport
Parkdale	Doug Woolweaver	dwoolweaver@parkdalemills.com	Industrial, Medical, Sports, Apparel, Home Furnishings
AATCC	Peggy Pickett	pickettp@aatcc.org	Apparel, Home Furnishings, Medical, Protection, Sport

National Spinning Co. Inc	Jim Booterbaugh	jimb@natspin.com	Apparel, Home, Industrial, Medical, Environment, Protection, Sport
Hosiery Technology Center	Dan St. Louis	sockman@legsource.com	Apparel, Medical, Environmental, Sport, Military (willing to host a meeting in Hickory)
Shuford Mills	CP Davis	cpdavis@shufordmills.com	Sports, Home Furnishings

Appendix A12: Media

Textile World
Southern Textile News
Textile News July 2007

NC State Launches Effort To Build Performance Textiles Cluster

The North Carolina State University (NC State) College of Textiles, Raleigh, N.C., recently convened “Building the Performance Cluster in North Carolina,” a focus group meeting that brought together representatives of North Carolina textile-related companies, associations, government agencies and academic institutions, with the purpose of discussing present and future challenges and opportunities for the state’s performance textile industry. The focus group moderator was John Anderson, director, East Campus and Textile Technology Center, Gaston College, Belmont, N.C.

Dr. Blanton Godfrey, dean of the College of Textiles, opened the session with a welcome address. Godfrey’s address was followed by the presentation of a research study by Dr. Nancy Cassill, principal investigator, and graduate student Holli Nelson, who discussed the study’s objectives and expectations and defined performance textiles as “textile materials and products manufactured primarily for their technical and performance properties in addition to their aesthetic or decorative characteristics.” Dr. Trevor J. Little, professor and head of the college’s Textile & Apparel Technology & Management department, introduced the focus group’s 53 participants, who included representatives of 34 textile-related companies; in addition to association representatives, consultants, NC State faculty and graduate students, and project managers from the NC Department of Commerce.

In the course of the proceedings, the group discussed standards, innovation and value, communication and networking, next steps, and future actions to be carried out by the College of Textiles and the NC Department of Commerce.

Standards issues included the difficulties related to competing, differentiating and selling performance textile products because industry standards have not been established. It was determined that such standards must be established, as must standards related to social, ethical and environmental responsibilities.

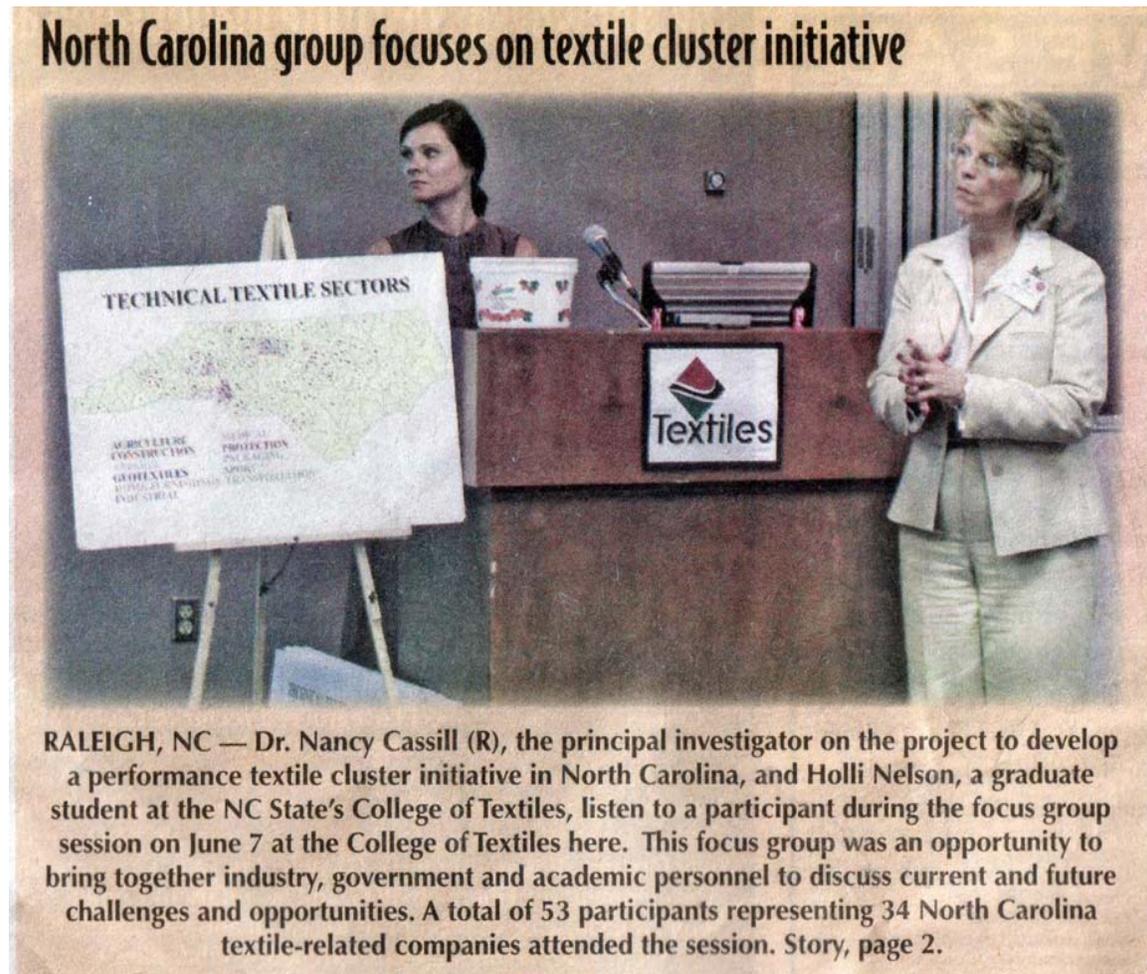
With regard to innovation and value, the group discussed the importance of research and new product development, noting that performance textiles require a longer timeline than traditional textiles both for design to market launch and for revenue generation. Also discussed was the need to effectively market value and performance benefits to consumers.

Participants also stressed the need for communicating and networking throughout the supply chain, and increasing public and global industry awareness of what North Carolina and the

Southeast have to offer in the way of performance textile resources and products. They also called for establishment of a neutral venue for meeting, and sharing and housing knowledge and information resources.

Next steps suggested include additional focus groups dedicated to specific performance applications; educational seminars covering topics such as product and product development, markets and trade, and other topics; and promotional efforts including regional trade shows. It was proposed that future activities should be held at a neutral venue, and that group participants as well as NC State and Department of Commerce personnel discuss and evaluate ongoing development of activities in order to provide research direction.

Future actions include facilitating the suggested next steps; pilot testing of the Textile Information Warehouse — a College of Textiles/Department of Commerce joint research project set to be launched this summer — by focus group participants; a performance textiles seminar targeting specific products, new product development and market considerations; and determining how to attract technical expertise and talent to the region.





John Anderson, director of the East Campus and the Textile Technology Center at Gaston College and moderator of the focus group, asks the 53 participants of the focus group a question at NC State's College of Textiles.

Industry group focuses on challenges, opportunities for NC's textile industry

RALEIGH, NC — North Carolina State University's College of Textiles on June 7 hosted an inaugural focus group meeting dedicated to develop a performance textile cluster initiative.

North Carolina is the location of many global companies competing in performance textiles. This inaugural focus group was an opportunity to bring together industry, government and academic personnel to discuss current and future challenges and opportunities.

A total of 53 participants attended the focus group, representing 34 North Carolina textile-related companies. Participants included industry leaders, consultants, association representatives, NC State faculty and graduate students and North Carolina Department of Commerce project managers.

The entire textile value chain, including fiber, yarn, fabric producers, manufacturers and suppliers, attended.

John Anderson, director of the East Campus and the Textile Technology Center at Gaston College, served as the moderator for the focus group.

The focus group was held as part of a research study on performance textiles in North Carolina. The research study is being funded by a grant from the NC Department of Commerce.

Dr. Nancy Cassill is the principal investigator on the project and Holli Nelson, a graduate student, are looking to identify specific needs of the performance textile industry in order to enhance global market competitiveness.

"The College of Textiles, working in close collaboration with the North Carolina Department of Commerce and industry, is providing information and direction that will directly assist the North Carolina textile complex in its global competitiveness objectives," Cassill said. "The college, a known global leader in research, education and outreach, is pleased to be a part of this collaboration between industry, government and academe in providing 'cutting edge' direction to help the dynamic North Carolina industry."

Questions focused on four distinct areas vital to understanding the performance textile industry and its sub-sectors: industry requirements, cluster

formation, trade and expertise and information needed for competitiveness.

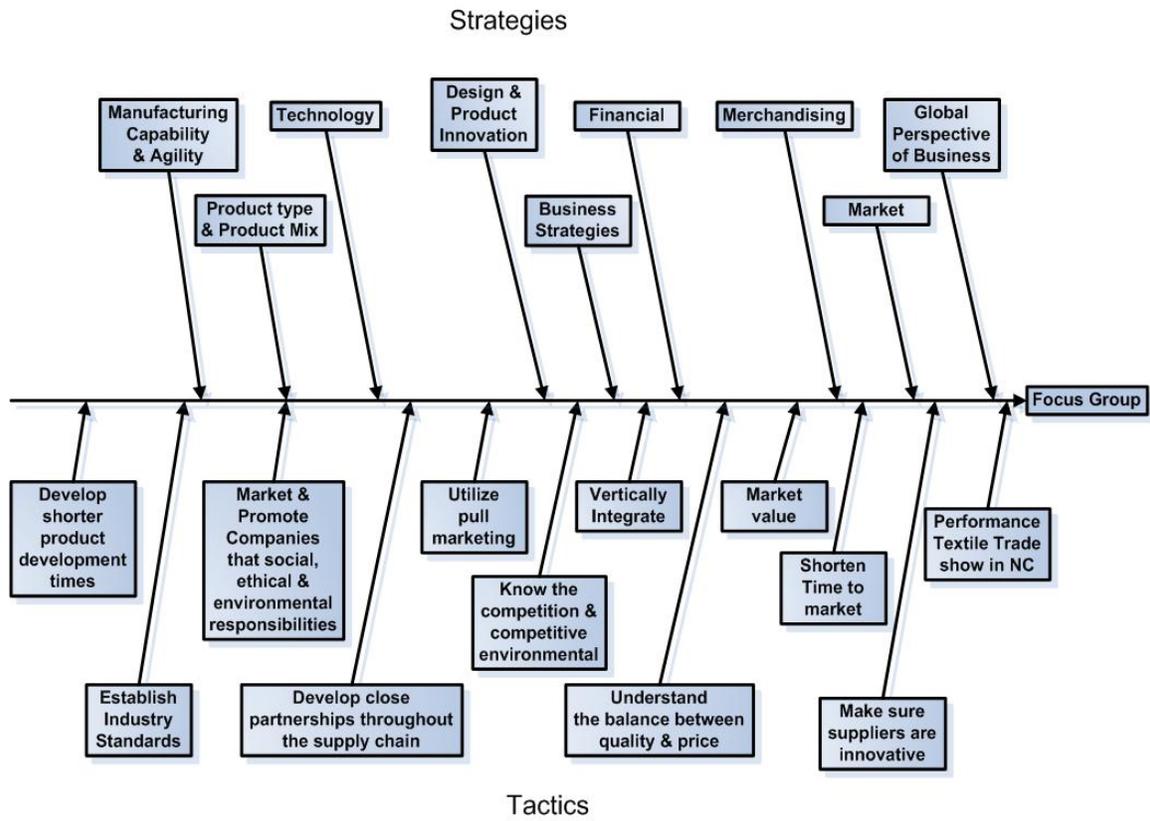
Performance textiles were defined as textile materials and products manufactured primarily for their technical and performance properties in addition to their aesthetic or decorative characteristics.

The next steps for this project include additional focus groups at a neutral site, such as NC State University, segmented by performance application. This will allow companies to meet and gain knowledge from one another as well as learn from the College of Textiles. Additional information learned about the companies will be helpful in the Textile Information Warehouse website that is being launched this summer.

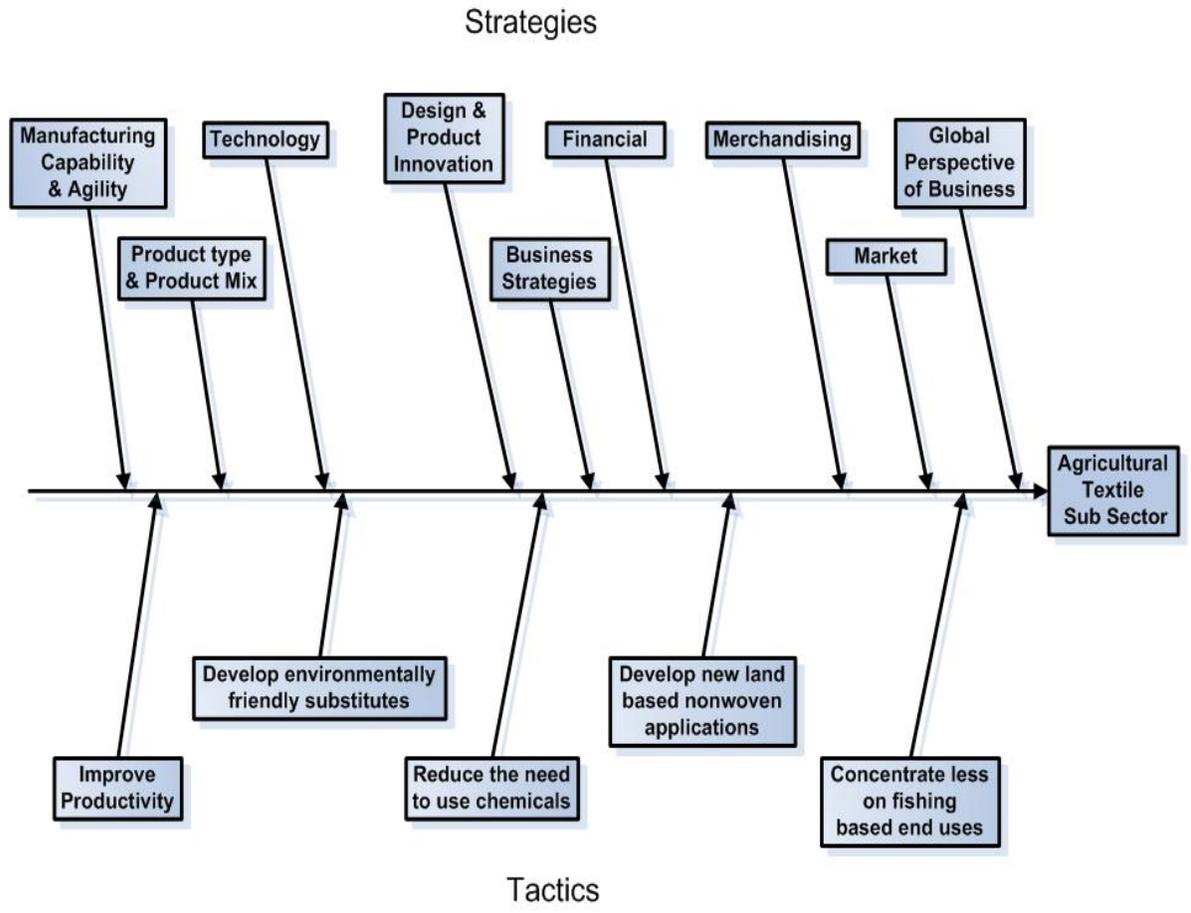
This is a project that is being completed by the College of Textiles and funded by the NC Department of Commerce. This website will be helpful for companies to find vendors in North Carolina that they may have not been aware of before. The project so far has identified 1,500 companies within the state. 

Appendix B- Fishbone Diagrams

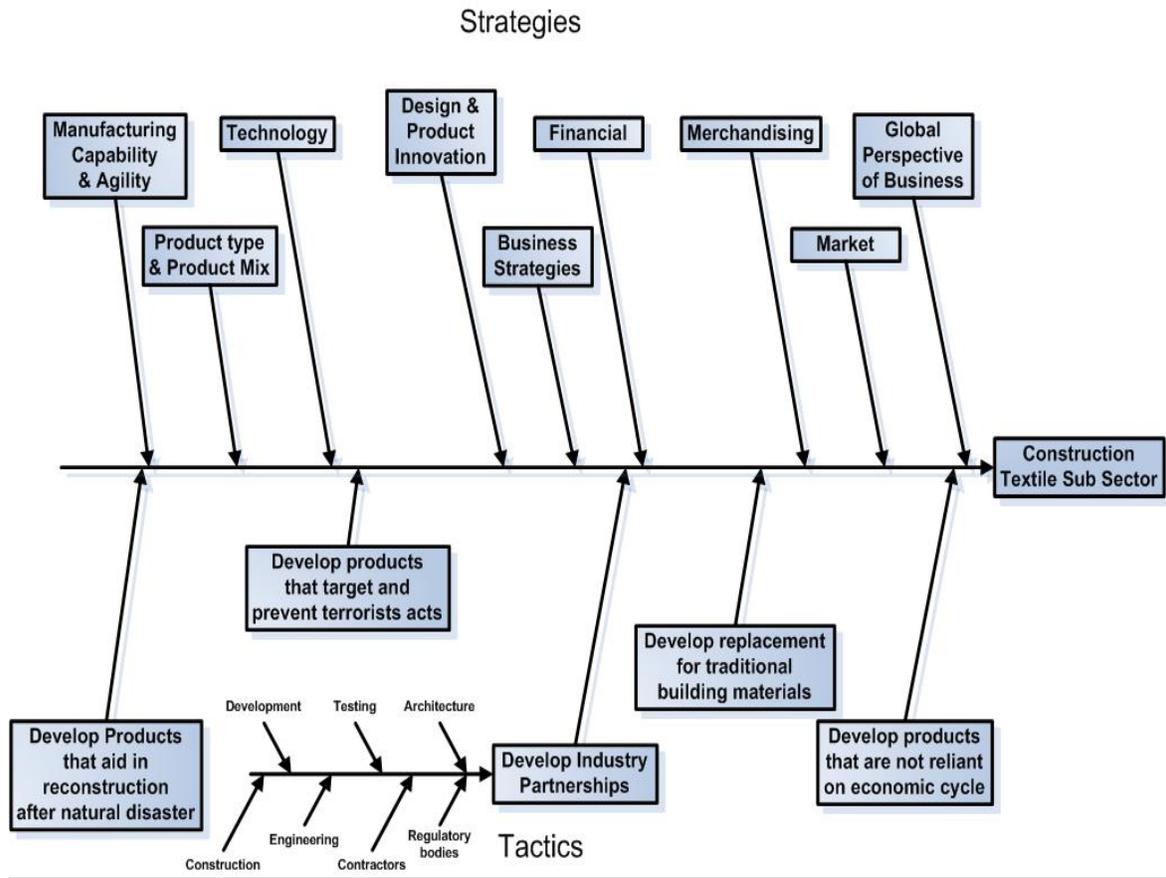
Appendix B1: Performance Textiles Fishbone



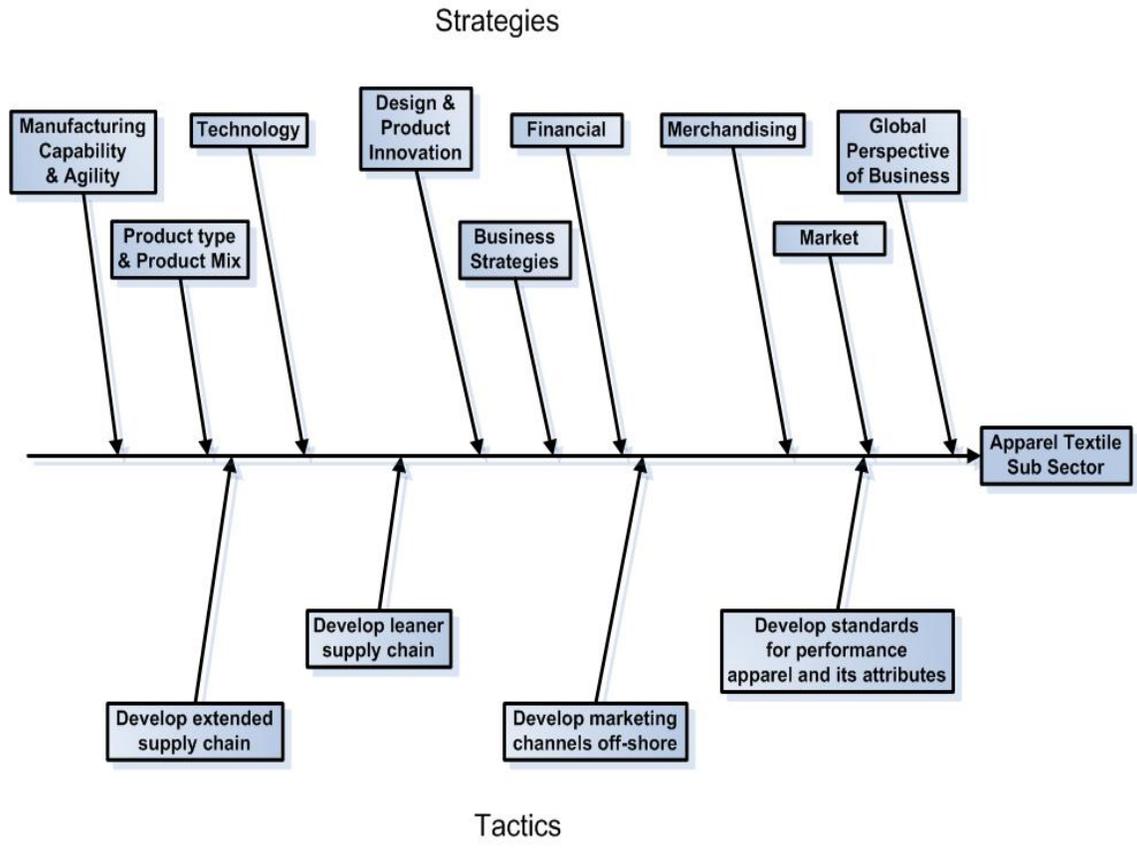
Appendix B2: Agricultural Fishbone



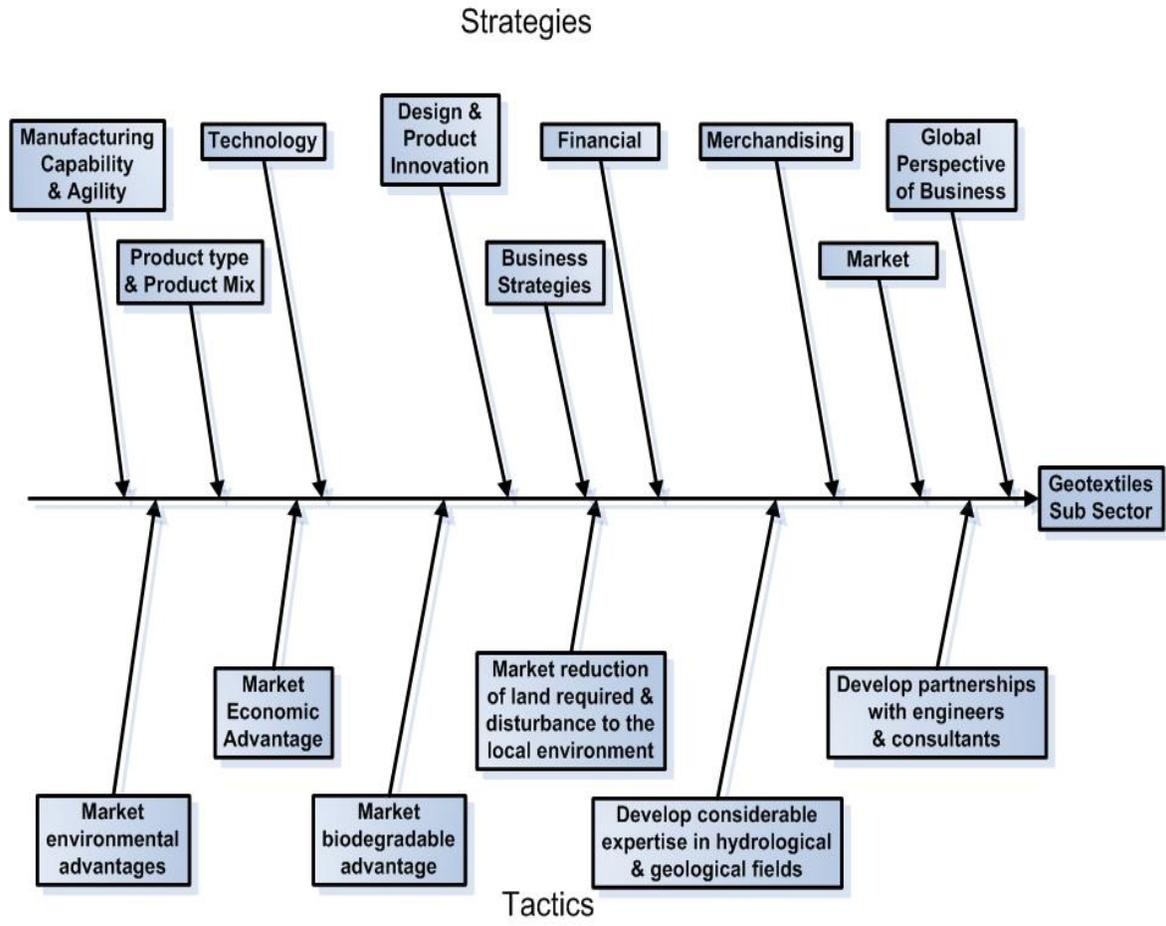
Appendix B3: Construction Fishbone



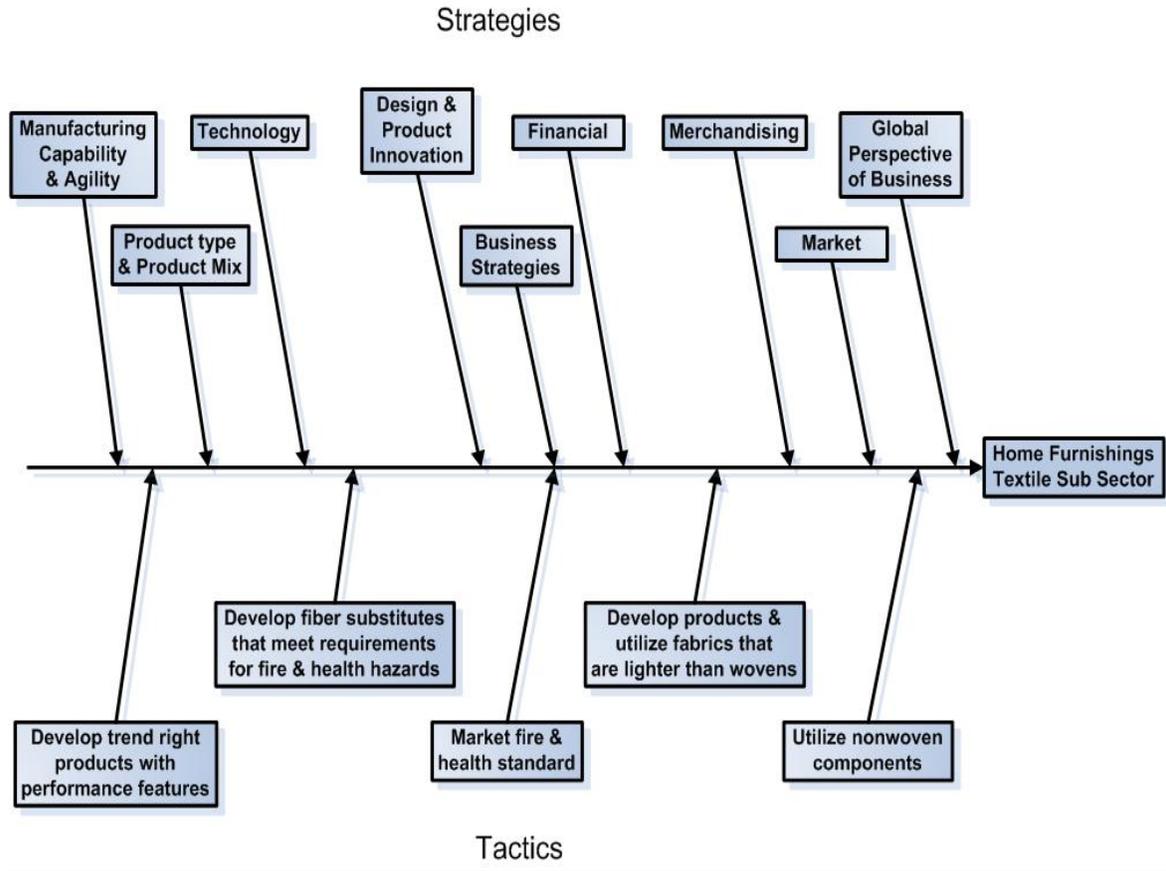
Appendix B4: Apparel Fishbone



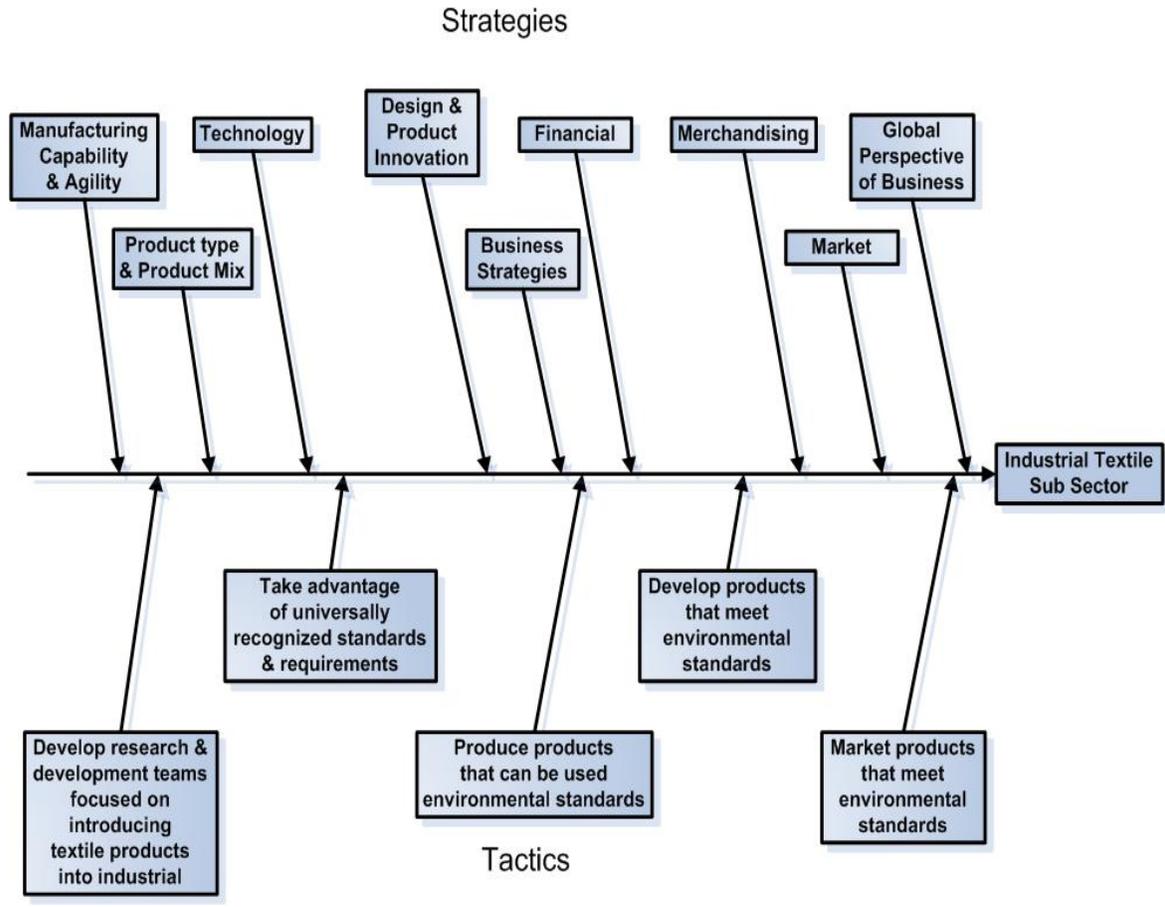
Appendix B5: Geotextiles Fishbone



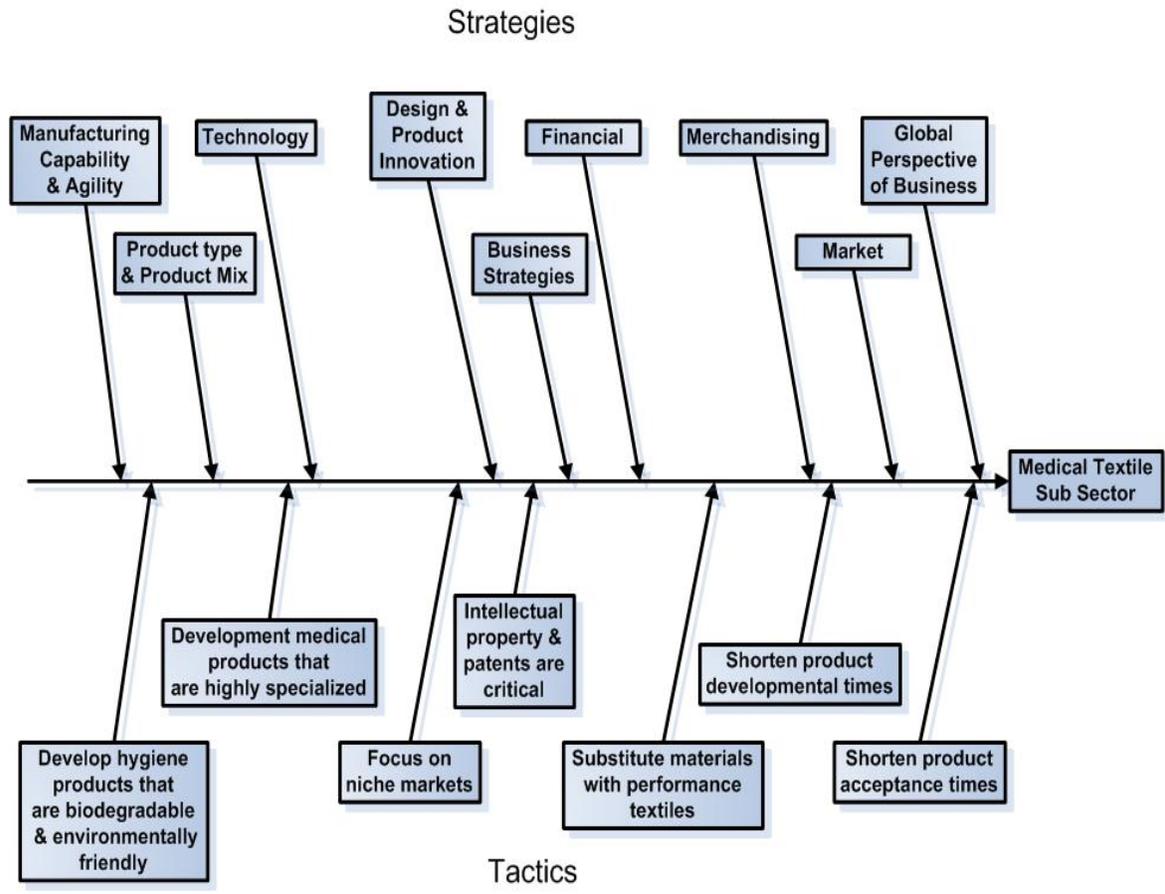
Appendix B6: Home Furnishings Fishbone



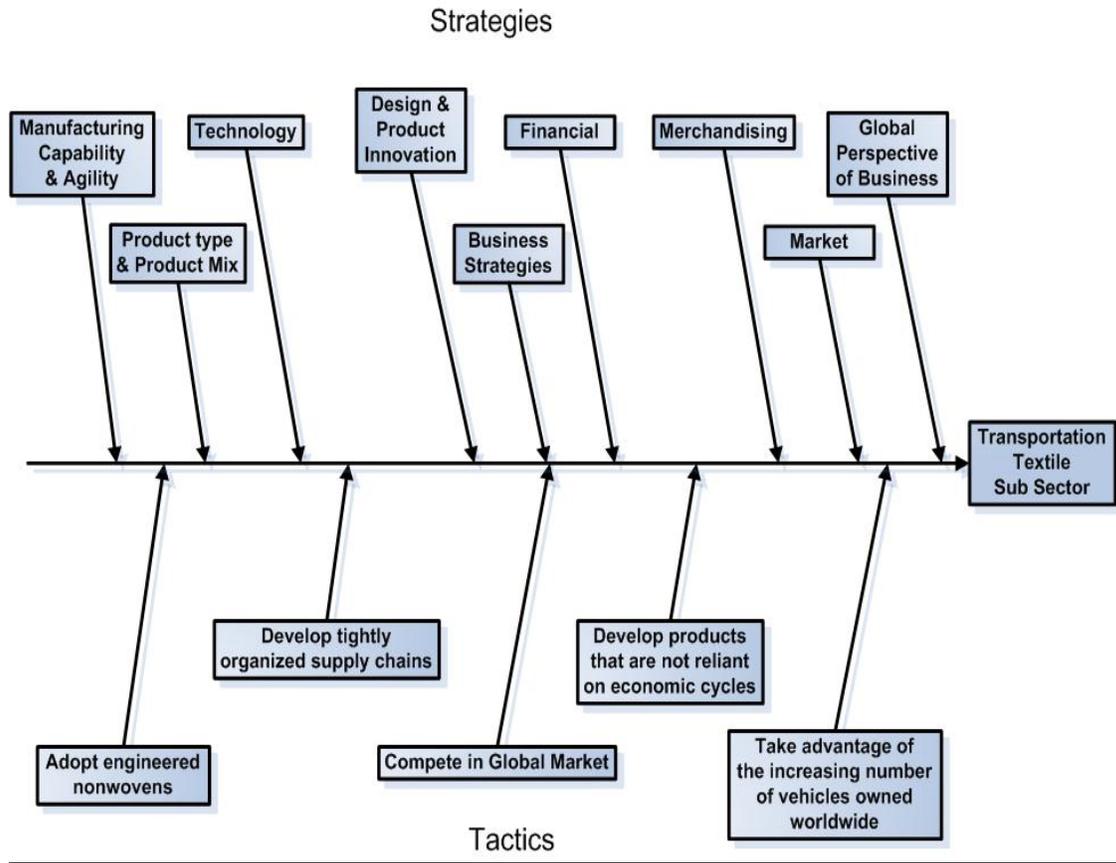
Appendix B7: Industrial Fishbone



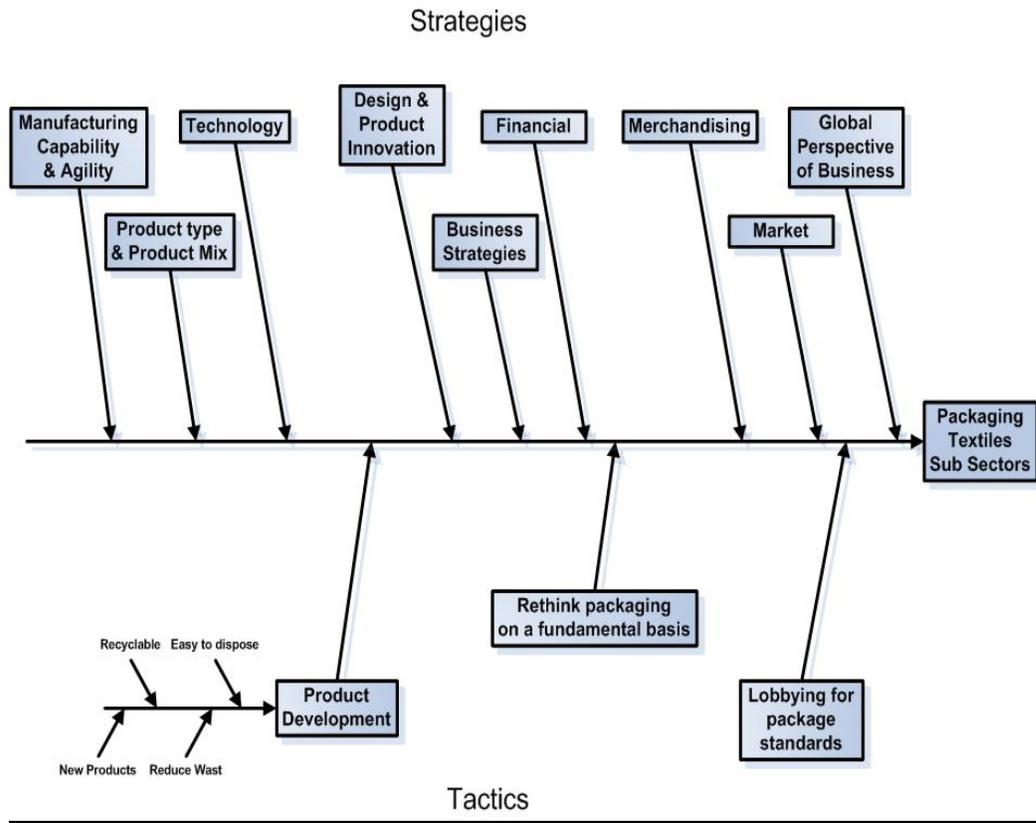
Appendix B8: Medical Fishbone



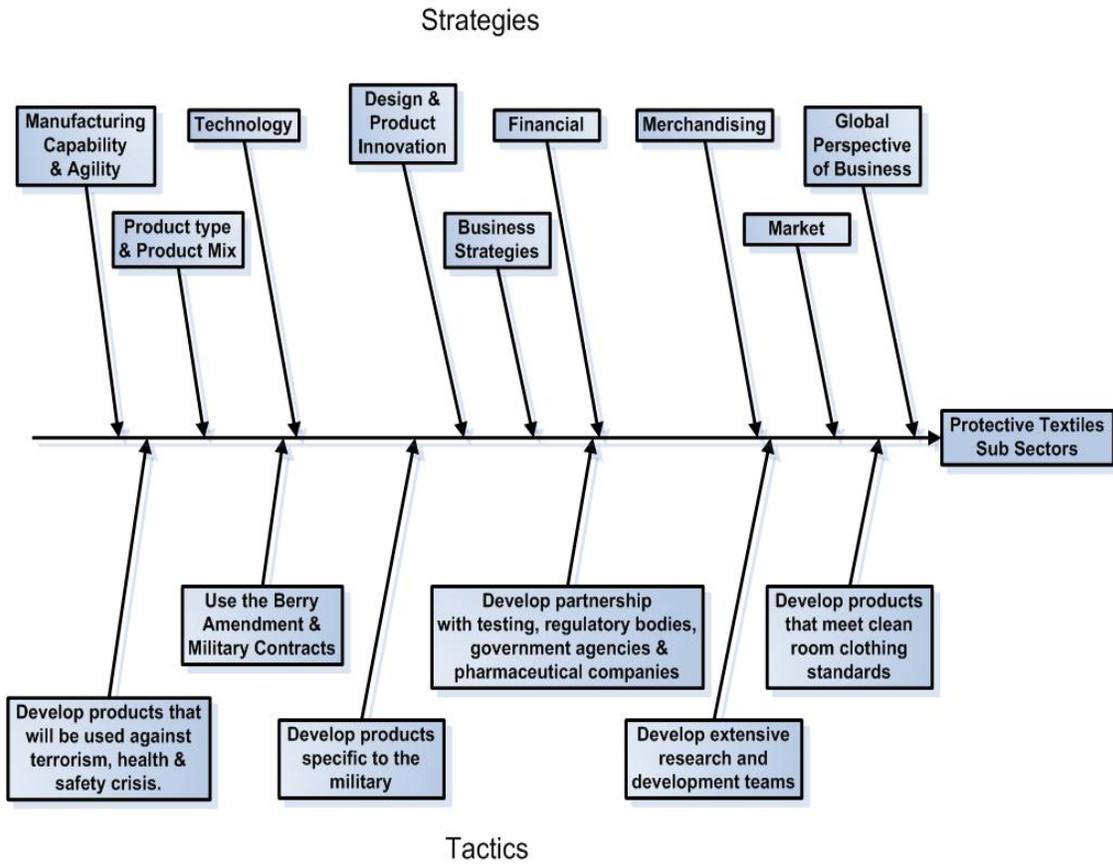
Appendix B9: Transportation Fishbone



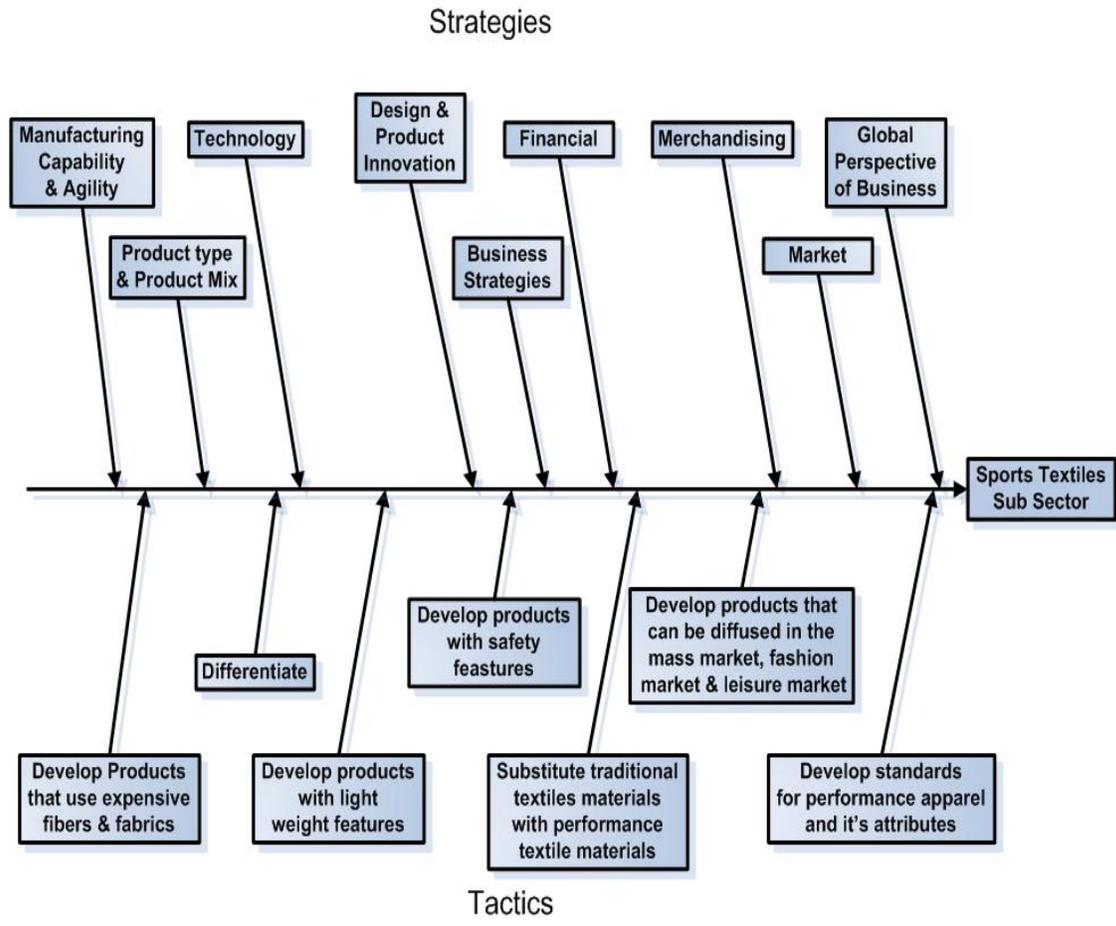
Appendix B10: Packaging Fishbone



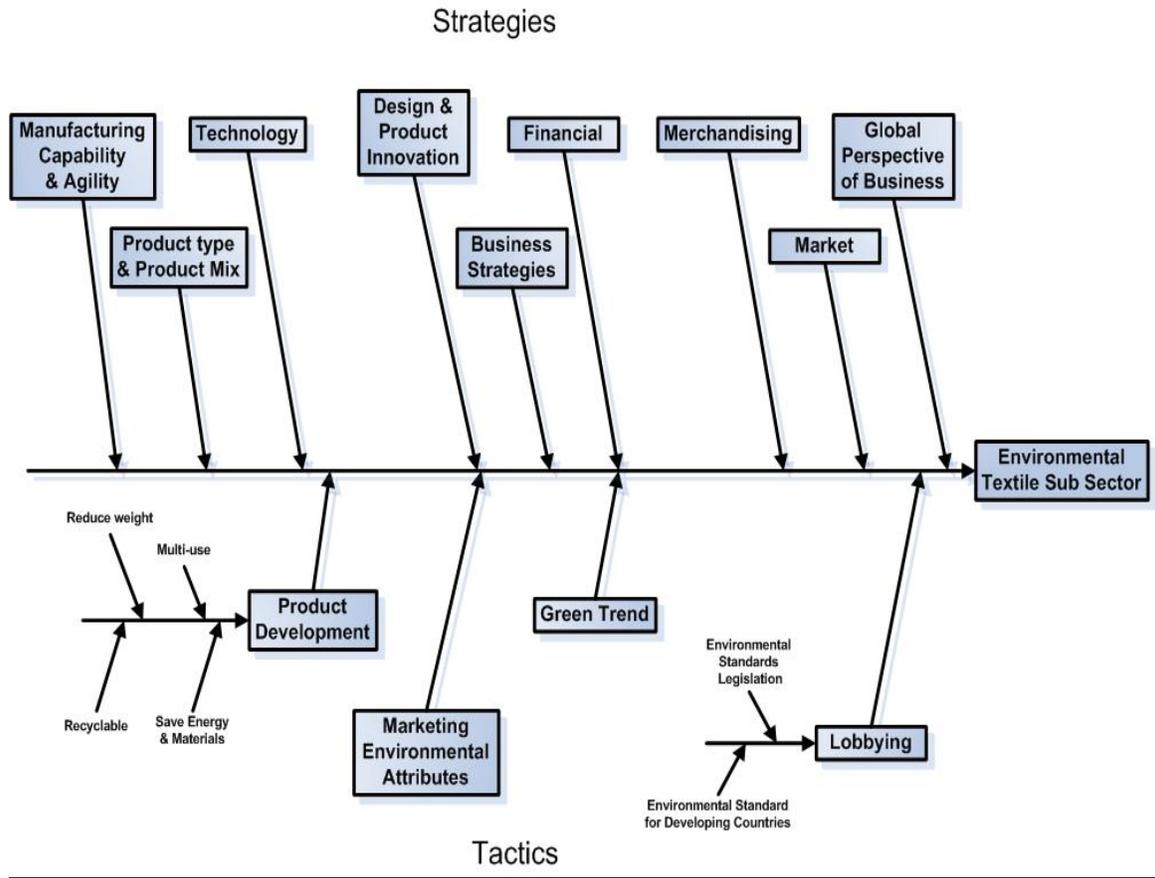
Appendix B11: Protection Fishbone



Appendix B12: Sport Fishbone



Appendix B13: Environmental Fishbone



Appendix C: Phase II Focus Groups

Appendix C1: Industrial Focus Group Sample Selection-Confirmed Participants

Industrial	INDA
Industrial	National Spinning
Industrial	DAK Americas LLC
Industrial	The Quantum Group, Inc
Industrial	American Truetzshler
Industrial	US DOC
Industrial	Fiber Visions
Industrial	Fiber Dynamics
Industrial	American and Efirid
Industrial	Invista
Industrial	Shuford Mills
Industrial	Service Thread Company

Appendix C2: Medical Focus Group Sample Selection-Confirmed Participants

Medical	Karl Mayer
Medical	Hosiery Technology Center
Medical	AATCC
Medical	Parkdale
Medical	Carolina Silver
Medical	PGI
Medical	Domestic Fabrics
Medical	Laam Science
Medical	Holt Hosiery
Medical	Carolina Narrow Fabrics
Medical	UNIFI
Medical	OTEXA
Medical	Quill Medical

Appendix C3: Protection Focus Group Sample Selection-Confirmed Participants

Protection	Spectrum Dyed Yarns
Protection	Hanes Brands
Protection	Glen Raven
Protection	International Market Solutions
Protection	Cocono
Protection	Carolina Mills
Protection	Burlington Labs
Protection	Daikin America, Inc
Protection	NCMBC
Protection	Military Foundation
Protection	Saab Group
Protection	Defense & Security Technology Accelerator
Protection	Domestic Fabrics
Protection	Longworth Industries/Polarmax

Appendix C4: Construction Focus Group Sample Selection-Confirmed Participants

Construction	US GreenFiber
Construction	Goulston Technologies, Inc
Construction	Carriff Corporation
Construction	PPG Industries
Construction	PPG Industries
Construction	DSM Dyneema
Construction	Engineering Tectonics
Construction	US DOC-OTEXA
Construction	Geosynthetic Corp
Construction	Hanes Geo Composites

Appendix C5: Invitation Email-Protection

North Carolina State University's College of Textiles is conducting a 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 aim of this study, funded by the North Carolina Department of Commerce, is to determine key ways to assist North Carolina textile companies producing and marketing performance textile products in achieving *global market competitiveness*.

Phase I of the study has been completed with identification of the performance industry, its characteristics, and cluster structure in North Carolina. Phase I was validated through a successful inaugural focus group in June 2007. Using information gathered at the first focus group, additional topics have been chosen with a narrowed focus for further discussion.

Phase II of the study focuses on further identifying and validating company placement, market dynamics, and growth opportunities. Because of your importance to North Carolina in the production and/or marketing of performance textiles for protection applications, we would like to invite you to the NC State College of Textiles to participate in a focus group February 18th from 9am-11am.

Mr. John Anderson, Director of the Textile Technology Center at Gaston College and formerly Vice President of Marketing and New Products at Wellman will continue to serve as moderator for the focus group.

Focus group topics will include global competitiveness factors, growth potential, market trends, innovation, added value, advanced manufacturing, quality, standards, technical performance, and next steps for the project. Outcomes of this session will include strategies that can assist the North Carolina textile industry, as well as individual companies, in global competitiveness and innovation in terms of performance textiles.

A key benefit of your company's focus group participation is the interaction with other North Carolina textile executives in the protection sector, as well as access to the study's findings in both Phase I and Phase II once completed in March 2008. Your company will have the ability to identify issues that impeded competitiveness and innovation in performance textile markets, and formulate way to improve such issues.

We hope that you will consider participating in this focus group and if you are unable to be with us, please recommend someone from your company most appropriate to participate. It is very important to have participation from you in Phase II of the project. Your representation is vital to this industry discussion.

Please confirm your participation with identification of company representative via email by Friday, February 8th 2008. All confirmations should be directed to Holli Nelson, hgnelson@ncsu.edu

Thank you for your time and consideration in participating in Phase II of this study. We look forward to seeing you February 18th from 9am-11am. Logistics and directions will be sent upon your confirmation.

Kind regards,

Nancy Cassill, Interim Department Head, Textile and Apparel Technology and Management

Blanton Godfrey, Dean of the College of Textiles

Trevor Little, Professor

Nancy Powell, Professor

Holli Nelson, Graduate Research Assistant

Appendix C6: Invitation Email-Industrial

North Carolina State University's College of Textiles is conducting a 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 aim of this study, funded by the North Carolina Department of Commerce, is to determine key ways to assist North Carolina textile companies producing and marketing performance textile products in achieving *global market competitiveness*.

Phase I of the study has been completed with identification of the performance industry, its characteristics, and cluster structure in North Carolina. Phase I was validated through a successful inaugural focus group in June 2007. Using information gathered at the first focus group, additional topics have been chosen with a narrowed focus for further discussion.

Phase II of the study focuses on further identifying and validating company placement, market dynamics, and growth opportunities. Because of your importance to North Carolina in the production and/or marketing of performance textiles for industrial applications, we would like to invite you to the NC State College of Textiles to participate in a focus group February 19th from 9am-11am.

Mr. John Anderson, Director of the Textile Technology Center at Gaston College and formerly Vice President of Marketing and New Products at Wellman will continue to serve as moderator for the focus group.

Focus group topics will include global competitiveness factors, growth potential, market trends, innovation, added value, advanced manufacturing, quality, standards, technical performance, and next steps for the project. Outcomes of this session will include strategies that can assist the North Carolina textile industry, as well as individual companies, in global competitiveness and innovation in terms of performance textiles.

A key benefit of your company's focus group participation is the interaction with other North Carolina textile executives in the industrial sector, as well as access to the study's findings in both Phase I and Phase II once completed in March 2008. Your company will have the ability to identify issues that impeded competitiveness and innovation in performance textile markets, and formulate way to improve such issues.

We hope that you will consider participating in this focus group and if you are unable to be with us, please recommend someone from your company most appropriate to participate. It is very important to have participation from you in Phase II of the project. Your representation is vital to this industry discussion.

Please confirm your participation with identification of company representative via email by Friday, February 8th 2008. All confirmations should be directed to Holli Nelson, hgnelson@ncsu.edu.

Thank you for your time and consideration in participating in Phase II of this study. We look forward to seeing you February 19th from 9am-11am. Logistics and directions will be sent upon you confirmation.

Kind regards,

Nancy Cassill, Interim Department Head, Textile and Apparel Technology and Management

Blanton Godfrey, Dean of the College of Textiles

Trevor Little, Professor

Nancy Powell, Professor

Holli Nelson, Graduate Research Assistant

Appendix C7: Invitation Email-Medical

North Carolina State University's College of Textiles is conducting a 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 aim of this study, funded by the North Carolina Department of Commerce, is to determine key ways to assist North Carolina textile companies producing and marketing performance textile products in achieving *global market competitiveness*.

Phase I of the study has been completed with identification of the performance industry, its characteristics, and cluster structure in North Carolina. Phase I was validated through a successful inaugural focus group in June 2007. Using information gathered at the first focus group, additional topics have been chosen with a narrowed focus for further discussion.

Phase II of the study focuses on further identifying and validating company placement, market dynamics, and growth opportunities. Because of your importance to North Carolina in the production and/or marketing of performance textiles for medical applications, we would like to invite you to the NC State College of Textiles to participate in a focus group February 18th from 1pm-3pm.

Mr. John Anderson, Director of the Textile Technology Center at Gaston College and formerly Vice President of Marketing and New Products at Wellman will continue to serve as moderator for the focus group.

Focus group topics will include global competitiveness factors, growth potential, market trends, innovation, added value, advanced manufacturing, quality, standards, technical performance, and next steps for the project. Outcomes of this session will include strategies that can assist the North Carolina textile industry, as well as individual companies, in global competitiveness and innovation in terms of performance textiles.

A key benefit of your company's focus group participation is the interaction with other North Carolina textile executives in the medical sector, as well as access to the study's findings in both Phase I and Phase II once completed in March 2008. Your company will have the ability to identify issues that impeded competitiveness and innovation in performance textile markets, and formulate way to improve such issues.

We hope that you will consider participating in this focus group and if you are unable to be with us, please recommend someone from your company most appropriate to participate. It is very important to have participation from you in Phase II of the project. Your representation is vital to this industry discussion.

Please confirm your participation with identification of company representative via email by Friday, February 8th 2008. All confirmations should be directed to Holli Nelson, hgnelson@ncsu.edu.

Thank you for your time and consideration in participating in Phase II of this study. We look forward to seeing you February 18th from 1pm-3pm. Logistics and directions will be sent upon you confirmation.

Kind regards,
Nancy Cassill, Interim Department Head, Textile and Apparel Technology and Management
Blanton Godfrey, Dean of the College of Textiles
Trevor Little, Professor
Nancy Powell, Professor
Holli Nelson, Graduate Research Assistant

Appendix C8: Invitation Email-Construction

North Carolina State University's College of Textiles is conducting a 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 aim of this study, funded by the North Carolina Department of Commerce, is to determine key ways to assist North Carolina textile companies producing and marketing performance textile products in achieving *global market competitiveness*.

Phase I of the study has been completed with identification of the performance industry, its characteristics, and cluster structure in North Carolina. Phase I was validated through a successful inaugural focus group in June 2007. Using information gathered at the first focus group, additional topics have been chosen with a narrowed focus for further discussion.

Phase II of the study focuses on further identifying and validating company placement, market dynamics, and growth opportunities. Because of your importance to North Carolina in the production and/or marketing of performance textiles for construction applications, we would like to invite you to the NC State College of Textiles to participate in a focus group February 19th from 1pm-3pm.

Mr. John Anderson, Director of the Textile Technology Center at Gaston College and formerly Vice President of Marketing and New Products at Wellman will continue to serve as moderator for the focus group.

Focus group topics will include global competitiveness factors, growth potential, market trends, innovation, added value, advanced manufacturing, quality, standards, technical performance, and next steps for the project. Outcomes of this session will include strategies that can assist the North Carolina textile industry, as well as individual companies, in global competitiveness and innovation in terms of performance textiles.

A key benefit of your company's focus group participation is the interaction with other North Carolina textile executives in the construction sector, as well as access to the study's findings in both Phase I and Phase II once completed in March 2008. Your company will have the ability to identify issues that impeded competitiveness and innovation in performance textile markets, and formulate way to improve such issues.

We hope that you will consider participating in this focus group and if you are unable to be with us, please recommend someone from your company most appropriate to participate. It is very important to have participation from you in Phase II of the project. Your representation is vital to this industry discussion.

Please confirm your participation with identification of company representative via email by Friday, February 8th 2008. All confirmations should be directed to Holli Nelson, hgnelson@ncsu.edu.

Thank you for your time and consideration in participating in Phase II of this study. We look forward to seeing you February 19th from 1pm-3pm. Logistics and directions will be sent upon you confirmation.

Kind regards,

Nancy Cassill, Interim Department Head, Textile and Apparel Technology and Management

Blanton Godfrey, Dean of the College of Textiles

Trevor Little, Professor

Nancy Powell, Professor

Holli Nelson, Graduate Research Assistant

Appendix C9: Logistics Email

Thank you for agreeing to participate in the NC State College of Textiles focus group devoted to the__ textile market. The focus group will be held on February __ at __. The session will be held at the RENCI Center located across from the College of Textiles.

The focus group will begin promptly at __. Directions to the RENCI center are attached. You will need to secure a parking permit at the Visitor Center as you enter Centennial Campus. Parking is available in the Textile Visitor Lot, as well as other locations, as identified by the Visitor Center attendant. Please tell the attendant you are here for the __ focus group.

Attached you will find an attendee list, and focus group topics. All focus group discussions will be confidential. We are hoping to collect general ideas and concerns in order to provide the North Carolina Department of Commerce with a general understanding of the industry's dynamics. Individual responses and companies will not be cited.

If you have any further questions or concerns, please contact Holli Nelson, holli.nelson@gmail.com. Also if you have any questions or problems the day of the focus group, please feel free to call Holli at 336-880-5088.

Thank you in advance for your participation. We look forward to seeing you.

Best regards,
Holli Nelson

Appendix C10: Directions

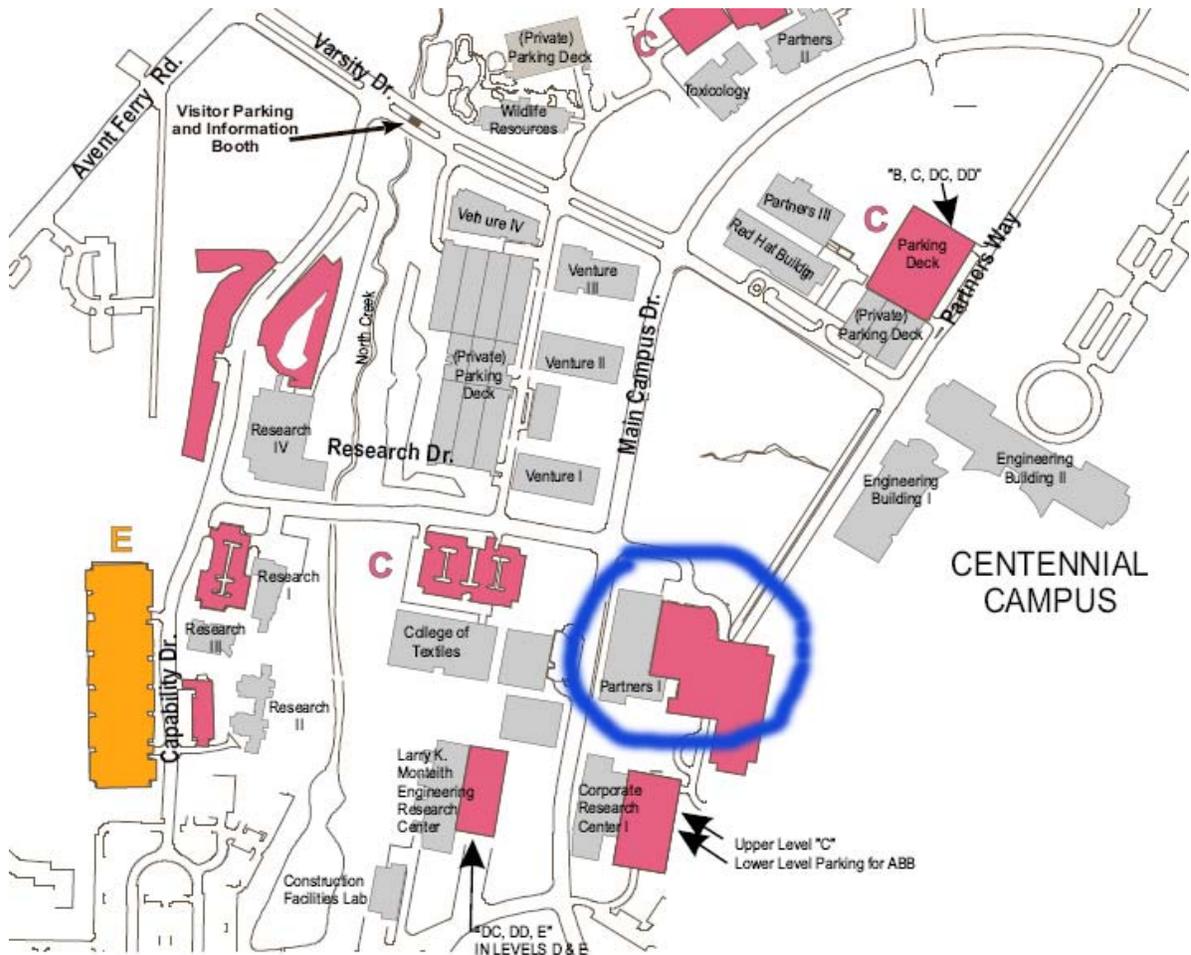
Directions to Partners I Suite 1500: RENCI/NCSU Engagement Facility

From UNC Chapel Hill, I-40 coming east:

Take Gorman Street exit. Turn left onto Gorman. Turn right at second light onto Avent Ferry Road. Pass Trailwood Drive (light) and turn right at next light onto Varsity Drive.

Then stop at the Information Booth on Varsity Drive to obtain a parking pass.

Drive straight down Varsity Drive, to the first stop sign, and turn right on Main Campus Drive, go past the first (Research Drive) intersection and turn left into the Partner Parking Area (see Map below) and park in the back of the Partners I Building. Walk to the Partners I Building and we are located in Partners I Suite 1500 on the first floor of the building.



Appendix C11: Agenda/Moderator's Guide

Phase II
Building the Performance Cluster in North Carolina:
Providing Assistance to Enhance Global Market Competitiveness of the North Carolina
Textile Industry

NC State University, College of Textiles
North Carolina Department of Commerce

Holli Nelson, Graduate Student
Nancy Cassill, Ph. D
Trevor Little, Ph. D
Nancy Powell

John Anderson, Moderator

February 18th, 9-11 am (Protective, Military Textile Focus Group)
February 18th, 1-3 pm (Medical Textile Focus Group)
February 19th, 9-11 am (Industrial Textile Focus Group)
February 19th, 1-3 pm (Geotextile, Construction Textile Focus Group)

Section 1: Global Competitiveness Factors, Growth Potential, and Market Trends

1. Discuss your product mix, markets served, and customer base.

2. Can you categorize your company using the 12 Performance Industry Sub-Sectors. Which sub-sector do you feel best represents your company?

Division	End Uses	Application
Agriculture	agriculture, horticulture, forestry and fishing	cover, protection, collection, fishing, tying
Construction	building and construction	protection, display, textile constructions, building components, reinforcements
Apparel	technical components of shoes and clothing	shoe components, insulation, structure, sewing, products
Geotextiles	geotextiles and civil engineering	stabilization, separation, drainage, soil reinforcement, erosion control, linings
Home Furnishings	components of furniture, household textiles, and floor coverings	carpet components, furniture components, cleaning, filtration, ticking, composites
Industrial	filtration, cleaning and other industrial materials	filtration, MRG's, cleaning, lifting, pulling, electrical, components, other
Medical	hygiene and medical	cleaning, cover stock, wound care, protection
Transportation	automotive, marine, railways, and aerospace	MRGs, safety, trim, insulation, floor covering, protection, composites, other
Packaging	packaging	bulk packaging, disposable, tying, other
Protection	personal and property protection	particulate protection, chemical protection, flame retardant, cut resistant, outdoor use, other
Sport	sport and leisure equipment	luggage components, sports equipment, camping equipment, other
Environmental	environmental protection	products extracted from the above

3. What key trends in the textile industry (economic, industrial) have had the most impact on your company?

4. Discuss competitiveness factors in terms of the performance textile industry. Which are the most important to your sub-sector?

Economic

Innovation/Technological

Environmental

Location

Skill of workforce

Market Need, Growth

OTHER

5. How is competitiveness achieved?

Product selection
Manufacturing ability
Marketing
Relationships
Market Research
Quality
Strategic Alliance
Other

6. Is there less competition in this sector? Is it a sector based on price competition or quality competition?

7. What are the growth opportunities in your sub-sector?

8. How did your company begin competing in this sub-sector?

Section 2: Innovation, Added Value, Advanced Manufacturing

2. Is your sub-sector led by technology push or market pull?

3. In what ways is your company attempting to increase productivity and profitability? How do you see the state playing a role in this process?

3. It has been reported that innovations in performance textiles occur daily? Do you believe this to be true? Do innovations in your sub-sector occur daily OR HOW OFTEN? HOW DO YOU MEASURE THIS?

4. What are your strategies for innovation and adding value?

5. Where does the innovation for your sub-sector stem?

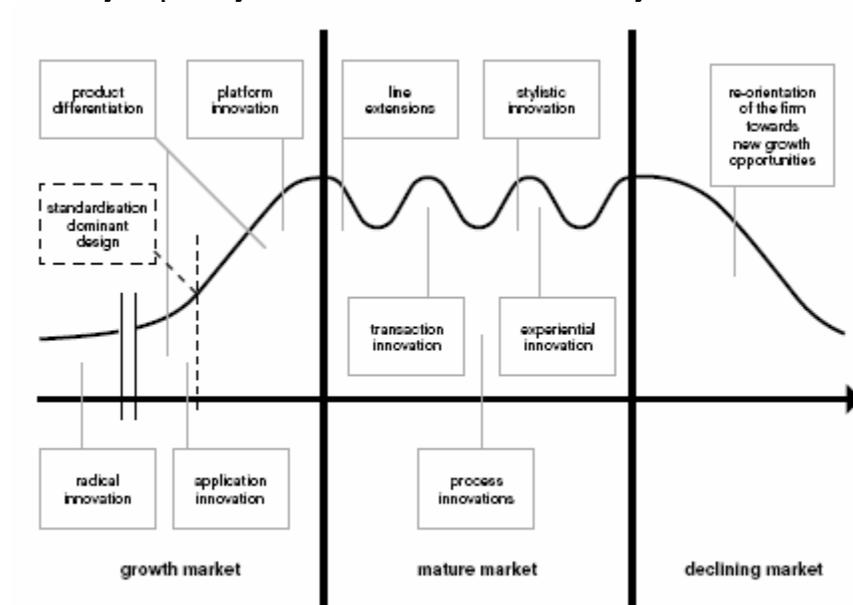
Customers
Suppliers
Buyers
Raw material producers

6. What types of innovation does your company participate in?

Radical
Transaction
Line extension

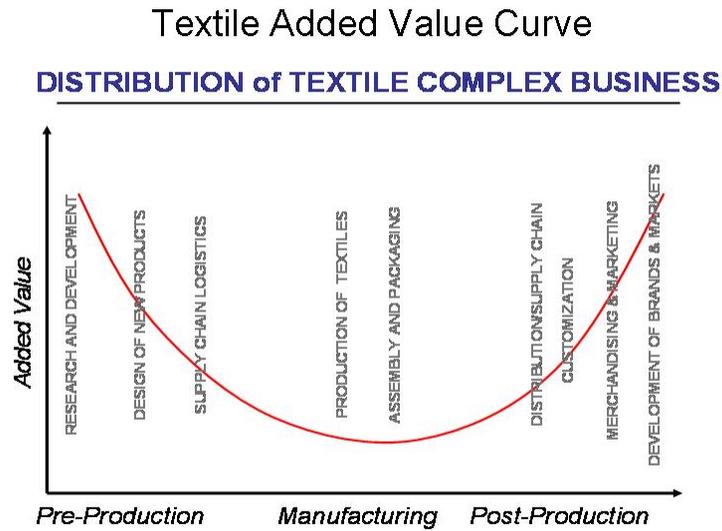
Process
Technical
Non technical

7. Where would you place yourself on the innovation lifecycle?



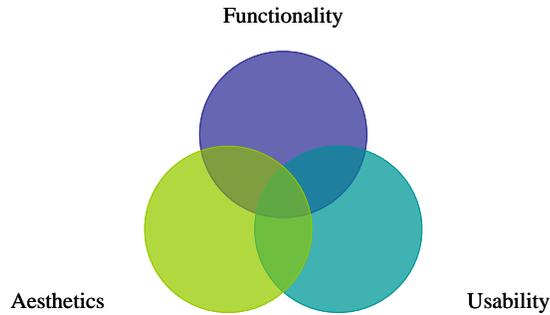
8. Do you agree with the Innovation Lifecycle model? Is it applicable to the dynamics of your business?

9. Where does your company add value? Use textile added-value curve.



Preproduction
Postproduction
Manufacturing

10. Adding value is generally contingent upon three dimensions: functionality, aesthetics, usability. How does your company balance these dimensions?



Section 3: Quality, Standards, Technical Performance

1. What are industry requirements for competing in the technical textile sector? (may be specific to the company and its' end product)
2. Reports state that often domestic companies chose to source performance textiles from the United States due to quality assurance, performance requirements, and standards. Is this the case in your sub-sector? **HAVE YOU/ARE YOU CONSIDERING TAKING PRODUCTION FOR PERFORMANCE TEXTILES OUT OF THE US?**
3. How important is speed in your sub-sector? Apparel retailers are pushed to provide fast fashion, quick turnaround, and fast replenishment. Is this an issue in your sub-sector?
4. Which industry standards/ requirements are most important to your sub-sector? Is there a need for additional standards/ requirements? If so, explain.
5. What were the barriers to entry?
6. Can the Berry Amendment and the increase in military demands enhance the profitability of companies competing in the technical textile sector?
7. Market expansion in both China and India are timely topics in terms of textiles and apparel. Does your sub-sector export to these markets? Have you seen an increased demand for products by these markets? **WHAT ABOUT COMPETITION IN PERFORMANCE TEXTILES FROM THESE MARKETS?**

Section 4: Industry Needs, Next Steps, Recommendations

1. What do you see as the major advantages for being located in NC?
2. What do you see as the performance textile industry's greatest needs in North Carolina? What changes would be necessary to help your business grow?
3. What have been the state's shortcomings in facilitating the textile/performance textile industry? What are the disadvantages in locating here?
4. What are the current issues (both positive and negative) facing your sub-sector?
5. What does your company need to stay competitive? Can your needs be met through local/state entities such as North Carolina Dept. of Commerce, academia, or service associations?

6. Would seminars devoted to performance industry issues be beneficial to your company?
What topics would you like discussed?

7. Does your company plan to expand to other performance textile markets?

Appendix C12: Thank You Email

Thank you for attending the NC State College of Textiles (insert focus group name) focus group. Your participation was vital to the success of the Performance Textiles research project.

Attached is an executive summary of all four focus groups (protection, medical, industrial, and geotextile) in addition to contact information for all participants. Ideally, this information will be valuable for continued and new business development opportunities in North Carolina.

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 you or your company with additional information or resources.

Appendix C13: Executive Summary

Executive Summary:

Phase II: Focus Groups (Protective, Medical, Industrial, Geotextile)

A research project funded by the North Carolina Department of Commerce

***Building the Performance Cluster in North Carolina:
Providing Assistance to Enhance Global Market Competitiveness
of the North Carolina Textile Industry***

**RENCI Computing Center, NCSU Centennial Campus
February 18th and 19th, 2008**

**Holli Nelson, Graduate Student
College of Textiles, Textile and Apparel Technology and Management (TATM)
Nancy Cassill, TATM Interim Department Head
Trevor Little, Professor
Blanton Godfrey, Dean-College of Textiles**

North Carolina State University's College of Textiles held four focus groups dedicated towards understanding the protective (military), industrial, medical, and geotextile performance market segments in North Carolina on February 18th and 19th, 2008, in the RENCI computing facility. The focus groups served as Phase II of the North Carolina Department of Commerce research project. Phase I was completed June 2007 with an inaugural focus group session specific to understanding the performance textile industry. The Phase II focus groups continued this discussion with a more narrowed approach. Phase II focus groups provided industry with the opportunity to discuss current and future business development opportunities as well as provide the North Carolina Department of Commerce with strategies for assistance.

Thirty eight industry representatives attended the focus groups and represented 37 North Carolina companies. A total of 12 participants attended the protective (military focus group) and 11 participants attended the medical textile focus group; both were held on February 18th from 9-11am and 1-3 pm respectively. On February 19th, 7 participants attended the industrial textile focus group from 9-11am and 8 participants attended the geotextile focus group from 1-3 pm. Focus group discussions were supplemented with six telephone interviews and one email interview. Participants included industry leaders, consultants, and association representatives. Additionally, NC State faculty, graduate students, and North Carolina Department of Commerce project managers were invited to listen to the discussions.

John Anderson, Director of East Campus and Textile Technology Center at Gaston College served as the primary moderator for each focus group. Holli Nelson, graduate student, helped to guide the discussion as well. Each two hour focus group was centered on four distinct areas vital to understanding the market structure and its' needs. These topics included: global competitiveness factors, growth potential, market trends, innovation, added value, quality, standards, technical performance, industry needs, and recommendations.

Phase II focus groups indicated and further validated the significant presence of the performance textile industry in North Carolina. Additionally, there is a significant interest in growing the performance textile cluster. In order to achieve sustained growth in terms of the performance textile industry in North Carolina, there are five general needs that must be addressed:

6. Increased innovation communication (Innovation partnerships with academia, commerce, industry, and entrepreneurs).
7. Commercialization assistance (Assistance in bringing innovations, new products, and technologies to market).
8. Workforce recruitment, retainment, and development (Attract workers to the performance textile industry).
9. Increased promotion of www.nctextileconnect.com and the availability of statewide networking sessions for business partnerships, development, and supply chain needs.
10. Development of a more attractive business environment in North Carolina.

Below are key points discussed at each focus group:

Protection (Military) Textile Focus Group Findings

Section 1: Global Competitiveness Factors, Growth Potential, and Market Trends

- Trends affecting the protective (military) market include: foreign competition, supply chain difficulties, foreign manufacturing relationships, commercialization processes, the cyclical nature of supplying to the military, and the impending election.
- Also, the ease of supplying to foreign military markets is a trend in this sector. Companies find supplying to allied countries can have fewer barriers to entry than supplying domestically. This is an opportunity for all companies.
- In terms of the impending election there are issues specific to the Department of Defense's budget level, political differences, and procurement levels. The election could prove to be disruptive for this market.
- To be competitive, companies cannot only supply to the military market. Protective applications in all forms are the key to competitive advantage in the Western Hemisphere.
- The Berry Amendment plays a major role in the protective market. Companies must be proactive in keeping the Berry Amendment intact. Additionally, certain waivers to the Berry Amendment are critical to companies' success and competitiveness. The key theme associated with the Berry Amendment is the continued need to fully understand the legislation and use the legislation advantageously.
- Growth opportunities for the protective market include: ballistic protection, silver technology, armor plating, AMWRAP vehicles, anti-coagulates, composites, anti-radar, anti radiation, comfort, climate protection, function, and degradation of fiber abrasion.
- In terms of apparel, export opportunities exist in the form of workwear.
- Growth potential for this sector in terms of connecting global technologies is integral at the University level. Dissemination of global research to North Carolina companies is needed. This will allow companies to stay ahead of the innovation curve and be proactive in the development of appropriate technologies.

Section 2: Innovation, Added Value, Advanced Manufacturing

- In this sector, there is not a method for radical innovations. Radical, disruptive innovations are difficult to push through in this market.
- Innovation is often driven through proposals, grants, and research incentives.
- Additionally, innovation is driven by the specification of standards. Adhering to specifications and standards can discourage radical innovation.
- In terms of this sector, technology is most successful if it is pulled through the supply chain by the final customer. Innovation stems from providing solutions to the needs of the military, first responders, and other protective workforces.
- For the protective market, demand push exists in innovations with disruptive

technologies that could be taken to the military; then bridged into other technologies (process innovations and line extensions).

- Entrepreneurs and young innovative companies are pushing innovation on to the final customer.

Section 3: Quality, Standards, Technical Performance

- Developing new specifications is a challenge in this market. Many specifications are old or written for a specific company.
- There needs to be continued communication about specifications in order to begin developing a level playing field.
- In terms of testing, there is a need to demonstrate at an ensemble level. Testing of all components is important, but testing a complete ensemble is most beneficial in terms of understanding comfort, climate, and movement.
- A challenge for testing processes is speed. There is a need for better testing access, quick turn around in labs, and help with prototype development.
- TPACC at NCSU has the ability to do the type of testing needed for the protective market. A challenge is expense.

Section 4: Industry Needs, Next Steps, Recommendations

- North Carolina is advantageous to the protective/military market because of its' infrastructure and the critical mass of textile companies.
- Companies competing in this market need: facilitation of communication in terms of R&D, innovation, and technological advances, help with commercialization, ballistics testing facility, a better understanding of the end user's needs, a role in developing specifications, better communication with procurement officials, and incentives for innovation.
- In developing future seminars, meetings, or forums companies competing in this market want information specific to: the needs of the industry, the needs of the military, and the needs of the customer. Seminars devoted in entering foreign military markets would be helpful, in addition to commercialization and new product development seminars.
- Strategic military meetings are needed. Topics and speakers should include: procurement leaders, Berry Amendment experts, export assistance in terms of allied military markets, specification development assistance, technical reports on new, global innovations, and standards.
- North Carolina State University could serve as a partnering body. If the University understands the core competencies of a company, they can develop partnerships and strategic alliances with other companies.
- An increased promotion of Textile Connect (www.textileconnect.com) is needed.

Medical Textile Focus Group Findings

Section 1: Global Competitiveness Factors, Growth Potential, and Market Trends

- Market trends affecting the medical textile market include: the lack of raw material, the aging population, the war in Iraq, returning soldiers, infection control, functional products, over the counter medications, anti viral, anti bird flu, corporate America's need to protect employees, chemical warfare, consumer lifestyle changes, shorter operating times, less invasive surgeries, the lack of technical equipment/machinery for innovative medical products, and athletic performance enhancement.
- Competitiveness factors include: the availability of raw materials, lack of technical expertise in the workforce, dispersed ancillary services, the FDA, the consolidation of the warp knitting machinery industry, and hospital reimbursement.
- The medical market has one of the largest barriers to entry. It is an expensive market, requires long product development lead times, and switching costs are high.
- Competitiveness can be achieved through value pricing. Quality is very important in this sector. Buying groups, hospitals, and insurance companies must be educated on the price/value ratio and the need for value enhanced products.
- Competitive products must be evaluated on a cost per use basis. The lifecycle of a product must be taken into consideration. The lowest cost product is not always the best choice in long term situations.
- The price balance is a challenge in this industry. If a product is priced at the lowest cost, it can be viewed as a commodity product. Increasing the price often commands an increased sense of value. Price is not as important in the medical market, especially niche medical markets. There is room for the best product in this sector, no matter the price.
- As a whole the medical market is a growth opportunity. The medical market provides a venue for quality textile products. Growth opportunities include supplying to the military, providing products that are radically innovative, protection from bird flu, viruses, infection, infection associated with food control, developing countries, and self medication/self diagnosis.
- Also, the cross over between the medical industry and the veterinary industry is a growth opportunity.

Section 2: Innovation, Added Value, Advanced Manufacturing

- Success factors for product development for the medical market include: meeting the patient's needs, developing a successful product, adequate funding, commercial distribution, and product placement.
- Entrepreneurs for the medical market are pushing technology through the supply chain to the final customer.

- Innovations also stem from the needs of doctor, surgeons, and patients. Innovations derive from improved medical tools, processes, and the need for quicker surgeries, less invasive operations, and faster healing times.
- Most often a need in the market is uncovered and technologies are developed or improved upon to meet this need.
- Replacement materials (fibers) for traditional applications are characterized by the growth stage of the Innovation Lifecycle.
- Innovative manufacturing processes and equipment are needed to commercialize products. Machinery innovations are used to improve current medical tools and add value to traditional tools. Fabric finishing for medical applications also adds value to the manufacturing process.

Section 3: Quality, Standards, Technical Performance

- In terms of quality, standards, and technical performance, one of the key themes was associated with third party certification parties used in justifying cost per use data.
- Companies need credibility for marketing the value associated with their products. Validation of cost per use is important for persuading buying groups, insurance companies, doctors, surgeons, and hospitals to specify new products.
- In the medical industry, standards can inhibit innovation and competitive advantage. Standards deter growth because one cannot demonstrate superiority.
- Additionally, consumers need to be educated. The market is saturated with anti-microbial, wicking materials, climate control, odor control, etc. Do consumers really know what all of this means? Do they want of all these characteristics? Consumers have no understanding of standards.
- Retailers, brands, and marketing programs devalue technical characteristics such as wicking and antimicrobial.
- The FDA is difficult to work with, yet FDA approval is critical for success. Approval committees are helpful, but the process can be time consuming.
- Human trials are sometimes needed in terms of testing and this can be very expensive.
-

Section 4: Industry Needs, Next Steps, Recommendations

- The major advantages of doing business in North Carolina include: the proximity to the University and community college system, labor availability, textile engineering expertise, customer base, and manufacturing facilities.
- A challenge of doing business in the state is the dispersion of technological skill. As the textile industry has dispersed, the skill of the workforce has also dispersed. Additionally, certain skill sets are disappearing as the workforce ages.
- Employees who have lost textile jobs are hesitant to re-enter the textile workforce.

- Companies must be creative in the recruitment of employees. Companies attract employees by advertising itself as a medical company, biomedical company, or chemical company.
- A need for the continued promotion of manufacturing jobs as a viable career path is critical for continued growth in terms of the medical market.
- Recruitment in middle and high school is important. Choices other than a 4 year college degree are needed. There is a need for trade school and vocational opportunities. The North Carolina education system needs to advocate other options besides a 4 year degree from a University.
- Future seminar topics specific to the medical market should include: information on R&D, raw material supply, acquiring FDA certification, entering international markets, distribution, product placement, connectivity, improving processes, chemical based innovations, and the State's capabilities for supporting this industry.
- The State could further develop the medical sector by offering economic incentives, research grants, and funding opportunities. Technology needs to be linked with entrepreneurs and venture capitalists. Confidentiality is a factor.
- Network opportunities are needed with patients, doctors, surgeons, buying groups, insurance companies, and hospitals.
- An increased promotion of Textile Connect (www.textileconnect.com) is needed.

Industrial Textile Focus Group Findings

Section 1: Global Competitiveness Factors, Growth Potential, and Market Trends

- Oil prices, economic cycles, import competition and the consolidation of the domestic textile industry are trends that have impacted the industrial textile market.
- Specifically, the availability of raw materials is a trend that impacts pricing, manufacturing, and product market selection.
- Competition from China was a key theme in terms of fiber availability, cost pressure, new machinery demands, and intellectual property.
- Additionally, China has the opportunity to challenge domestic nonwoven manufacturing in the next 3 years.
- Foreign government subsidies provide challenges for domestic manufacturing and business development.
- Growth potential for the industrial market is specific to niche markets, the nonwovens industry, supplying the military, ballistic protection, flame retardant products, replacement fibers and materials, and value added fibers.
- In terms of the nonwovens industry, growth potential is linked to baby diapers, medical procedures (less invasive procedures), the automobile industry, providing opportunities for products that are lighter weight and less expensive and the apparel market.
- The competitiveness factors that are most important to the industrial textile market include: innovation and technological ability, economic stability, skill of the workforce, and intellectual property.
- Competitiveness in the industrial textile market is achieved through: product selection, providing a wide portfolio of products, quick reaction time to market trends, flexibility in manufacturing, partnerships throughout the supply chain, and providing a competitive price/performance ratio. Overall, if the price is not right, then the quality and product function is insignificant.
- The “green” movement is becoming a business driver. Companies are forced to improve their sustainable scorecard and carbon footprint. Green movement has become a reality, not a fad. Market research states that consumers will pay MORE for sustainable products. This is an opportunity for the market.
- There is a learning curve associated with the green movement. Consumers demand products in an ideal state; green, recyclable, cradle to cradle, etc. This is difficult to achieve at the mill level in terms of economic, cost, and speed barriers.

Section 2: Innovation, Added Value, Advanced Manufacturing

- Companies agree that awareness of the types of innovation and the innovation process is critical for sustainable growth opportunities. The textile industry as a whole has generally lagged in terms of technology advancements. Traditionally, the textile industry has focused on marketing strategies, not innovation strategies.

- Companies agree that radical innovations are always sought after, but generally process innovations occur more often achieved.
- Radical innovations can be achieved through new polymer and new fiber developments.
- Partnerships with the engineering industry are important in terms of innovations.
- Innovation is a combination of both market pull and technology push.
- In terms of successful innovations, generally a market pull approach is 50% successful while a technology push approach is 20% successful.
- In the industrial market, radical innovations can stem through motivated customers or through internal innovation strategies.
- Commercializing new products is a challenge; bringing radical innovations to market can be difficult.
- In terms of machinery development, innovation is achieved through partnerships with the end customer. End customers then force suppliers to purchase certain machinery and equipment.
- Value is added in the manufacturing process by providing flexible production strategies, running several products simultaneously, and adding performance coatings/finishing. Efficiency in the manufacturing process provides added value as well as a competitive advantage. Efficiency is often achieved through investments in new machinery.
- Manufacturing value can also be achieved by providing suitable, consistent products in order to achieve trade leadership.
- For a radical innovation or new product to be successful, a company must tie together all aspects of the supply chain.
- Innovation strategies are also used in the marketing and merchandising of new products and fibers. Branded fibers allow for a pull through in downstream relationships.
- 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.
- All agree that the nonwovens industry is characterized as a growth market in relation to the Innovation Lifecycle. In terms of nonwoven consumer products, the lifecycle is short but provides for various line and product extensions.
- Creating a “needs” list is important for developing innovations. Companies must stay current with customer needs and market needs.
- Transaction innovations can be achieved through an integrated supply chain. Speed is important in terms of supply chain innovations. Technical innovations can be achieved through tweaking existing products in terms of finishing, additives, and functionality. Non technical innovations are achieved through branding and marketing strategies. Opportunities exist in non technical innovations.

Section 3: Quality, Standards, Technical Performance

- There is a need to be proactive in creating an industry organization devoted to establishing standards, test methods, and quality certification.
- The nonwovens industry has been proactive in developing definitions and test methods. This is an opportunity for the textile industry. All aspects of the supply chain must work together in the development of standards and test methods.
- Guidance in terms of sustainability requirements and definitions is needed. Consumers need a better understanding of sustainable as well.
- Third party testing bodies are needed for validation. In terms of competitiveness, third party validation is important for credibility. NCSU, HTC, and Gaston Textile Technology Center are three places in the state that this can be done.
- Third party testing facilities can be difficult to work with. Difficulties include: turn around time, market acceptance, confidentiality, expense, problematic terms and conditions, dogmatic legal aspects, access to expertise and accommodations of the needs of companies.
- Suggestions for improving third party testing facilities include: readjusting the sense of urgency, correlation between payment and research quality, personal liaisons to ensure progress, ongoing dialogue, hands on management, and vested interest between the organization and the company.
- Have NCSU as third party authority provides advantages and credibility in the market acceptance of new innovations, technologies, and products.

Section 4: Industry Needs, Next Steps, Recommendations

- Advantages of North Carolina include: transportation, University and community college system, existing textile workforce, State incentives, and the port system.
- Challenges of doing business in North Carolina include: electrical costs, mentality associated with the “death of the textile industry”, retaining workforce, recruiting manufacturing workforce, and high taxes.
- A key theme associated with this focus group included the workforce in North Carolina. There is an access to intelligent, high skill workforce. There is a need for continued recruitment of entry level workers. Many are skeptical to work in the textile industry because of the textile stigma. There is a need to change the workers’ mindset. The state needs to make manufacturing jobs more attractive.
- The competitiveness of South Carolina was discussed. Companies believe South Carolina does a better job in recruiting companies and employees. The South Carolina textile industry is more aligned with the government. There is a strong effort in South Carolina to help the textile industry.

- North Carolina needs to reposition itself. There is too much focus on the Research Triangle Park area. North Carolina needs to think about its core competencies (textiles) and rebuild companies around these competencies. Textiles are and will be a viable industry...the perception of the state must reflect this.
- Possible seminar topics include: new polymer technologies, new fiber forming technologies, and understanding the sustainable movement.
- Suggestions for the creation of a statewide “needs” list. What do customers need? What do consumers need? What does the military need? What do other market segments need?
- There needs to be a better understanding of the type and level of research done by the Universities. Better research communication can lead to partnership opportunities. There needs to be a synergy between the Universities, industry, entrepreneurs, and the Department of Commerce.
- North Carolina needs to be more proactive in recruiting companies to the State. The Charlotte area is very attractive for the industrial sector.
- An increased promotion of Textile Connect (www.textileconnect.com) is needed.

Geotextile (Construction) Market Focus Group Findings

Section 1: Global Competitiveness Factors, Growth Potential, and Market Trends

- Market trends for the geotextile and construction include: increased labor costs, cyclical nature of the housing industry, the economy, climate change, a shift towards finer yarns, foreign competition, consolidation of the market, political environment, increased export opportunities in developing markets, and the movement towards eco-friendly products.
- Many geotextile products are considered commodities and are subject to increased off-shore competition especially from Asia.
- Competitiveness factors include: meeting regulatory requirements in terms of environmental needs, economic cycles, price, ability to prove cost savings, and the ability to sell performance.
- Competitiveness is achieved through the appropriate value proposition for a specific product. Value based pricing is important in this market. There is a need for cost comparison validation.
- Competitiveness is also achieved by convincing the public and private sector, as well as engineers to specify geotextile products.
- Growth opportunities include: construction applications, the Mexican market, export opportunities in Asia, providing specialty products to the Chinese market, products that give solutions to problems associated with population increases (waste, water, living area), sustainable products, and replacement materials.
- Export opportunities are idealistic for geotextile products; they are roll goods thus easy to ship.
- Challenges associated with competing in this market include: the Department of Transportation, the ability to validate cost savings and the price/performance ratio, domestic innovation (too secretive), climate change (no longer a need for some products), and switching costs.
- As environmental concerns continue to escalate, there will be a growth in terms of demand for geotextile products. Meeting environmental needs is the basis for many geotextile products. The next step is to provide technical, innovative products to add value to the product's function.

Section 2: Innovation, Added Value, Advanced Manufacturing

- Generally, innovation in this market stems from process innovations and line extensions. Products that are improved through innovations are more likely to be specified because of its' uniqueness and function.
- Once a product has been standardized, there is a push to find new applications for products.
- The engineering industry is an important supporting sector in this market and often drives the pace of innovation and need for quality products.

- If an innovation occurs and a geotextile product becomes specified that product has the competitive advantage. This is difficult and is contingent upon commercialization times and speed to market.
- Innovation must merge science and marketing (technical and non-technical innovations). The industry needs help with this type of merger.
- Radical innovations are driven by mega-trends; ballistics, fiberglass, and the green movement. What is the next mega-trend?
- Radical innovations also occur in the woven geotextile sector.
- Innovation is pulled by the customer in most cases. What does the customer want? There is a need to connect with the downstream customer in terms of innovating to meet needs.
- Push strategies include looking to other markets (complementary industries).
- Energy conservation, coal availability, and pollutants are also driving innovation.
- Value can be added in the manufacturing process by investing in new equipment and new product assembly lines. Thus, products can be converted more efficiently and economically.

Section 3: Quality, Standards, Technical Performance

- ASTM standards, military specifications, and GRI standards are important to the geotextile and construction market.
- GRI is an industry specific standard association.
- Companies need credibility for marketing the value associated with their products. Validation of cost per use is important for negotiating with the Department of Transportation and Federal Highway Administration.
- Developing specifications for products is important for achieving competitive advantage and deterring from foreign competition.
- The geotextile supply chain is rather short; manufacturing to distributor to contractor.
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Section 4: Industry Needs, Next Steps, Recommendations

- North Carolina is advantageous in terms of the geotextile sector because of the textile presence, highly educated workforce, access to ports, and the supply of raw materials.
- Working with the Department of Transportation is difficult and is one of the state's shortcomings in facilitating development in this industry.
- The tax system in North Carolina is not favorable to manufacturing and energy costs are high.
- Although geotextiles are generally nonwoven materials and North Carolina has a large nonwoven presence, this is not an advantage. Nonwoven manufacturing in North Carolina is not equipped to handle many of the large rolls needed to supply the geotextile market. An opportunity exists to meet this demand.
- Recommendations for the State include: networking sessions to locate manufacturers,

understanding export opportunities, facilitating communication with the Department of Transportation, and understanding legislation.

- An increased promotion of Textile Connect (www.textileconnect.com) is needed.

Appendix C14: Media

A press release/media article was developed by John Anderson using the executive summary of the Phase II groups.

Building the Performance Cluster in North Carolina
February 18-19
North Carolina State University College of Textiles
Phase II: Focus Groups (Protective, Medical, Industrial, Geotextile)

On February 18th and 19th, 2008, North Carolina State University's College of Textiles held four focus groups dedicated towards understanding the protective (military), industrial, medical, and geotextile performance market segments in North Carolina.

The focus groups served as Phase II of the North Carolina Department of Commerce research project. Phase I was completed June 2007 with an inaugural focus group session specific to understanding the performance textile industry, as reported in Trends. The Phase II focus groups continued this discussion with a more narrowed approach. Thirty eight industry representatives attended the focus groups and represented 37 North Carolina companies. Phase II focus groups provided industry with the opportunity to discuss current and future business development opportunities as well as provide the North Carolina Department of Commerce with strategies for assistance.

John Anderson, Director of East Campus and Textile Technology Center at Gaston College served as the primary moderator for each focus group. Holli Nelson, graduate student, helped to guide the discussion as well. Holli was responsible for all of the logistics and succeeded in assembling four distinct panels of industry leaders, consultants, and association representatives.

Holli Nelson prepared the executive summary of the two days plus supplementary phone interviews. Her work is drawn on heavily throughout this article. Each two hour focus group was centered on several distinct areas vital to understanding the market structure and its' needs. These topics included: global competitiveness factors, growth potential, market trends, innovation, added value, quality, standards, technical performance, industry needs, and recommendations.

As in June, the industry participants were extremely knowledgeable, and vocal on issues in their market segment. The interesting feature of these sessions was group size and scope. By segmenting markets within the broad umbrella of "Performance Fabrics," the smaller groups were able to focus on specific needs within the subset. In the larger June 2007

session, the broad categories of needs were summarized as “Standards”, Innovation support and Communications”

This time around, based on the input from the focus groups, common needs were summarized by Ms. Nelson as:

6. *Increased innovation communication (Innovation partnerships with academia, commerce, industry, and entrepreneurs).*
7. *Commercialization assistance (Assistance in bringing innovations, new products, and technologies to market).*
8. *Workforce recruitment, retention, and development (Attract workers to the performance textile industry).*
9. *Increased promotion of www.nctextileconnect.com and the availability of statewide networking sessions for business partnerships, development, and supply chain needs.*
10. *Development of a more attractive business environment in North Carolina.*

While there was a great deal of commonality between groups, there were also some significant differences by market area. This report will attempt to capture the essence of each group discussion.

The Protective (Military) market was perhaps the most animated of the four, reflecting the dynamics of that market. The 12 participants included representatives from industry as well as the North Carolina Military Business Center, the Military Foundation and the Defense and Security Technology Accelerator.

Opportunities for innovation and growth seem to abound in this segment, but navigating the government bureaucracy and actually connecting with individuals who can articulate needs and make a decision creates a major challenge for textile firms focusing on this sector. In addition, the buying patterns of the military procurement agencies are mercurial (my words), and create additional challenges for suppliers.

Communication and the need for future forums and facilitation was my takeaway from this group. The level of enthusiastic networking by the participants before and after the sessions and during a break was further evidence of this need.

The Medical Textile segment was equally intriguing, but more reserved in its overall tone. This is another growth market, and a discussion of the driving forces revealed why.” The ageing population, the war in Iraq, returning soldiers, infection control, functional products, over the counter medications, anti viral, anti bird flu, corporate America’s need to protect employees, chemical warfare, consumer lifestyle changes, shorter operating times, less invasive surgeries, the lack of technical equipment/machinery for innovative medical products, and athletic performance enhancement” were all raised by the group as drivers of need for both product and for innovation.

Challenges are present in this sector as well. Firms which successfully navigate the labyrinth of government regulation, health organization buying offices, long development

cycles and other obstacles find themselves challenged by workforce issues in North Carolina, and cited the negative image that cast on the textile industry by media, and even the State's own drive to attract people to biotech and other "high tech segments."

The participants in this group all gave the impression that they are succeeding in spite of the challenges. The firms were quite specialized, and the products that they produced were leaders in that niche.

The Industrial Textile focus group was smaller than the others in number, but populated with industry leaders and innovators who had either led their organizations through a metamorphosis from commodity producer to specialty provider, or who had successfully created or applied emerging technology to their benefit. Rory Holmes of INDA was a participant in this group, and shared the perspective of the nonwoven portion of the industry, which continues to grow in North Carolina.

There was a lot of energy in this group around the opportunities and challenges that accompany a growing interest in "sustainability" in portions of the industrial textile segment. Legitimate third party testing and certification also got significant air time, as did the workforce issues that had been raised by previous groups.

The final focus group examined textiles for construction and civil engineering. While this area uses significant amounts of textile product in the geo-textile arena which has a lot of similarities with commodity textiles, there are also opportunities for firms who innovate and specialize. Most of the product in this market is specified, in many cases by government agencies, where best long term solutions often take a back seat to budget pressures or a requirement to use low bidders.

Innovative materials developed for these markets do give their inventors a payback that can last many years until an even more innovative approach comes along.

By getting to a more market specific level, the groups not only validated the concept of a growing Performance textile industry in North Carolina, but also articulated needs that NC Department of Commerce and others can put into actionable support for the industry. As before, I was impressed with the level of professionalism exhibited by both students and faculty at NC State College of Textiles and the Department of Commerce.

There never has been one magic formula for economic success in an increasingly competitive global textile market. The 37 North Carolina companies which participated in this project all exhibited one common trait: adaptability. Each participant related a significant strategic initiative which allowed that firm to thrive in the face of change. The fact that the State of North Carolina continues to invest resources to help such companies succeed is a credit to the leadership in the State House as well.

Acknowledgments: Holli Nelson, the Graduate Student at North Carolina State College of Textiles who is engaged in this project, wrote an excellent "Executive Summary" of the meeting. Her summary served as the basic building block for this article. The writer directed the discussions. This article is a compilation of Holli Nelson's summary and my impressions.