Minnesota Textile and Apparel Industry: Assessing Current Customization Characteristics and Needs

Elizabeth Bye
University of Minnesota, 240 McNeal Hall
1985 Buford Avenue, St. Paul, MN 55108
ebye@che.umn.edu

ABSTRACT

The purpose of this study was to profile the current computer technologies, manufacturing strategies, and business practices occurring in the Minnesota textile and apparel industry. Currently, the industry is undergoing a shift from mass production of standardized products to mass customization of individualized products. Advances in computer technology and management methods allow customized products to be produced at a low cost, increasing consumer demand for individualized products and services. The survey was sent to 400 Minnesota textile and apparel manufacturers selected randomly from those identified by the Standard Industrial Classification (SIC) code to document the level of mass customization based on1) product development 2) computer technology, 3) business strategy, 4) manufacturing strategy, and 5) business environment. Results indicated that Minnesota textile and apparel industry showed great diversity in company size and product type. There was a wealth of expertise in customized products, so the potential for the development of mass customization is strong. Use of computer technology was low, so considering the increased and strategic use of computer technology, and the development or expanded use of a website to build potential markets would strengthen the industry.

Keywords: Apparel and textile industry, customization, computer technology, product development, Minnesota

Introduction

The textile and apparel industry is changing from a product-driven system to a consumer-driven system (Taplin, 1999). Changing consumer demands and the development of new computer technology support a move towards the concept of mass customization. To be successful, mass customization requires that the consumer be involved with the specifications of the product design at some point in the production cycle. In order to respond to consumer needs, manufacturers must take advantage of current computer technology and utilize modular design concepts to gain efficiencies (Duray, Ward, Milligan & Berry, 2000). This shift requires new perspectives in manufacturing and retailing.

Minnesota has over 700 textile and apparel manufacturers, the second highest number in the North Central region, who contribute over $44 million to the state's export economy (Minnesota Department of Trade and Economic Development, 2001). Over half the jobs in Minnesota are located in rural areas, where there is an increasing

need to diversify and optimize economic opportunities to maintain both economic and community vitality (Shea, 1999). Textile and apparel businesses of all sizes and types are a valuable part of both our urban and rural resources.

To determine if the Minnesota textile and apparel industry was ready to embrace mass customization, a current profile of the industry was required. The objective of this project was to profile current computer technologies, manufacturing strategies, and business practices occurring in the Minnesota textile and apparel industry. This will help direct resources and research to support economic development. The research questions focused on 1) product development 2) computer technology, 3) business strategy, 4) manufacturing strategy, and 5) business environment.

Review of Literature

Consumers are no longer satisfied with low cost, mass-produced products that lack a unique identity. Davis (1987) first suggested the term "mass customization" in the book Future Perfect to describe the production of one-of-a-kind products with the economies of mass production. Pine (1993) explains mass customization as providing enough variety in products so that almost everyone finds what they want at a reasonable cost. To remain competitive and grow, the Minnesota textile and apparel industry must be prepared to embrace new perspectives.

A needs assessment of the Michigan apparel and textile industry (Lee, Sontag & Slocum, 2002) described a majority of companies made up of less than 20 employees who produced a wide variety of products. Internal and external challenges lead to the identification of needs in the areas of product development, organization and management, technology, marketing, human resources, and sustainability. Two studies examined the importance of textile and apparel manufacturing to rural areas in Missouri and small textile and apparel

manufacturers in New York (Dickerson, Dalecki, & Meyer, 1991; McDowell & Hester, 1986). The Missouri study found apparel manufacturers critical to rural economies and identified improving competitiveness and increasing productivity as primary needs. In New York, information about marketing was identified as a major need along with technology, labor, and trade. The Office of Technology Assessment (1987) described the fragmented nature of the apparel industry and the problems this poses in global competition.

In response to the economic challenges in rural Minnesota, a research/outreach project was developed to conduct e-commerce training for textile and apparel businesses. The Midwest Textile and Apparel Directory (1998) was the starting point in identifying businesses to take part in an e-commerce workshop based on a modified Main Street Minnesota curriculum (1994) that focused on textiles and apparel. Over 45 rural businesses were trained throughout the state, and results showed an increase in use of the Internet for e-commerce (DeLong, Gahring, Bye, & Johnson, 2002). During the workshops, the team identified that common issues facing these businesses were a lack of product development knowledge, limited access to computer technology, and insufficient business resources. Most businesses were familiar with mass produced or one-of-kind customized products. Examining what happens to the product development process as consumers become involved will help manufacturers to be proactive in meeting consumer needs.

Many companies, including Land's End, Levi's, Nike, Timbuk2, and Beyond Fleece are operating at various levels of mass customization. Wu, Anderson, & Ulrich (1998) found there was interest in the co-design process by college students and by consumers of custom fitted "Original Spin Levis", and Tedeschi (2001) found that users of the custom shoe program at Nike were interested in having input on design. Effective use of existing manufacturing facilities and organizational structures to

adopt mass customization (Lee & Chen, 2000) and effective methods of gathering consumer information are concerns in industry, particularly for smaller manufacturers with limited resources.

Duray et al. (2000) suggest a model of processes and technologies used in developing and manufacturing products based on the point of customer entry to the development process and the approach to manufacturing. The model was validated using data from 126 mass-customizers representing six different industries that produce engineered products. Textile and apparel products were not included, but it is appropriate to test the model's applications to this industry because the engineering design process and the textile and apparel design process are related (LaBat & Sokolowski, 1999; Regan, Kincade, & Sheldon, 1998). As a sized product, apparel has unique characteristics in relation to the human body that do not exist in the engineered products studied by Duray et al (2000). In addition, textile and apparel products are developed in seasonal lines, several times a year and can begin development at various levels from original design to modification by the consumer after purchase (May-Plumlee & Little, 1999).

Mass customization is seen as an advantage for progressive domestic manufacturers due to consumer expectations for timely delivery, quick response, and the ability to develop niche markets. Under the mass production business model, domestic textile and apparel manufacturing lost over 600,000 jobs to cheaper overseas labor (Fralix, 2001). Many see mass customization as a way to strengthen the US manufacturing sector. Customized products will make-up 20-30% of all products sold in the next 10 years (Fralix, 2001). Though some of the technology to support full mass customization is still under development, there are many opportunities for companies to begin the transition to a mass customization environment. These include embracing current computer technology to facilitate short cycle manufacturing, individual ordering and shipping, improving

links with suppliers and retailers, and participating in market testing (Sheller & Rabon, 1997). Thus, to substantially contribute to defining and shaping this mass customization paradigm and strengthen Minnesota's textile and apparel industry it is essential that a profile of resources is developed.

Method

To build a profile of the Minnesota textile and apparel industry a questionnaire was developed based on two instruments from previous studies with a focus on mass customization. Questions from the Durey et al. (2000) study, Approaches to mass customization:Configurations and empirical validation, were modified from applications to hard industrial product to be specific to the textile and apparel industry with the use of content from Loker and Oh (2002). The phone interview questionnaire on technology, customization and domestic production (Loker & Oh, 2002) was used as a guide and adapted for mail survey to respondents who were both customizers and mass producers. A pretest of 15 companies was conducted and the instrument revised. The final 45 question instrument consisted of six sections focused on current practices involving product development, computer technology, business strategy, manufacturing strategy, and business environment. Questions concerned with product development focused on design specifications, sizing, industry standards, customization options, ordering options, and modularity. The computer technology section focused on computer-aided-design, electronic data interchange, point-of-purchase, and e-commerce. Business strategy questions included ordering, planning, and compensation practices for both their general business and the customized portion of their business. The questions focused on manufacturing strategy looked at the emphasis the company places on product, costing, and delivery. Manufacturing and assembly strategies were also requested. Business environment focused on market share, ROI, and customer base. Likert type scales, multiple choice, and

short answer question formats were used. Results of the study were available by request.

A sample of 400 textile and apparel manufacturers was randomly selected from the 2001 Reference USA database (2001) from all businesses coded under Standard Industrial Classification (SIC) 22 and 23 for textile and apparel industries. This sample included all textile and apparel manufacturers, not just those who could be identified as mass customizers. The company president received an initial letter explaining the project and inviting participation. The questionnaire was sent one week later and followed in two weeks by a postcard reminder to complete and return the questionnaire. The data was coded and analyzed using descriptive statistics including means, standard deviations, and ANOVA. The profile was developed based on the results.

Results

Profile of Industry
The Minnesota textile and apparel industry showed great diversity in company size, product type, and business strategy. The response rate from the 400 questionnaires was 17.5 % with 56 usable responses. Companies ranged in size from 1 to 300 employees with an average of 26 employees. Products varied from apparel, flags, and draperies to packs, boat covers, and industrial bags. Most products were sized and designed to meet end-user specifications. The overall use of computer technology for manufacturing was low, however, about 50% (n=28) of the businesses maintained websites for visibility with limited use for direct business transactions. The companies with websites tended to operate at a high level of mass production. Individual requests and needs were identified at the early design stage of product development for companies with a high level of customization, compared to the companies with a high level of mass production.

Product Development.
Respondents were asked to describe their product line using a Likert scale from (1) strongly disagree to (7) strongly agree. Product descriptions focused on design specifications, sizing, industry standards, customization options, ordering options, and modularity. Manufacturers were focused on meeting individual customer requests for design and delivery of a wide variety of products. Most products were sized for either an individual body or application. Products were generally not being designed for modification after the purchase or to be developed from modular parts (See Table 1).

Computer Technology.
Respondents were asked to indicate their use of computer technologies using a Likert scale from (1) 0 % to (7) 100%, including computer-aided-design, electronic data interchange, and point-of-purchase. The presence, purpose, and future plans for a company website were requested along with employee use of the Internet. Perceptions of the use of computer technology at the company were indicated using a Likert scale from (1) strongly disagree to (7) strongly agree. There was very limited use of manufacturing computer technology among Minnesota textile and apparel manufacturers (See Table 1). A few companies had made use of computer technology primarily for customer order tracking and material planning. 44% used electronic communication for purchase orders, however, other use of the web for transfer of funds, recording customization information, or order and delivery status was limited. Approximately 50% of the respondents (n=28) had a company website which they used for establishing company presence (100%), customer e-mail access (96.4%), and to share product offerings (96%). 50% used their websites to sell products, however the percentage of direct sales from their websites was very low (5.62% of business sales). However, expectations for increased sales via the website were projected to triple over the next two years (13.4%).

Business Strategy.

Respondents were asked to indicate ordering, planning, and compensation practices for both their general business and the customized portion of their business using multiple choice and short answer. Most of the companies took orders on a continuous basis throughout the year. Approximately 44% sold directly to the consumer, with the balance wholesale or corporate sales. Because of the wide range in size of Minnesota textile and apparel manufacturing companies, managing employees varied greatly from a one-person operation to production teams. The teams did meet to plan and discuss work processes, problems, and production (See Table 1).

Manufacturing Strategy.

Respondents used a Likert scale from (1) None to (7) Critical to indicate the emphasis the company places on product,

costing, and delivery. They also described manufacturing and assembly strategies. All companies placed a high value on developing new and unique products, reducing costs, and providing strong customer service and delivery. The majority of the companies made products to order (See Table 1).

Business Environment.

Respondents were asked to indicate their perceptions of the business environment using a Likert scale from (1) low to (7) high. Most businesses perceived that their market share and ROIs were significantly higher and they were performing at a level equal to or above those of their competitors. Most perceived a very rapid rate of change for customers taste and preference, and business environment overall was considered less predictable (See Table 1).

J
T
A
T
M

Table 1. Descriptive Statistics: Representative Summary of Six Profile Categories

	Mean	SD	Significant
Product Development			
Customized products are produced using the same process as other products	5.31	1.71	*
My customized products are more profitable than my standard products	5.31	1.89	**
Once a product is designed, it is repeated manufactured	4.36	2.14	
Products are designed to end-user specifications	6.12	1.21	**
Computer Technology			
Computer-Aided Design	1.94	1.92	*
Electronic Data Interchange	1.36	1.19	*
Decision Support System	1.55	1.30	*
Business Strategy			
Teams hold meetings to plan and discuss work processes, problems, and production	2.82	1.29	*
Channels of distribution are highly integrated	5.40	3.26	*
Manufacturing Strategy			
Develop unique product	5.25	1.74	
Offer customer involvement in design	5.35	1.54	
Reduce unit cost	4.84	1.82	
Provide after-sales service	5.42	1.65	
Meet delivery promises	6.49	0.85	
Business Environment			
Market Share	3.76	1.59	**
Return on Investment	3.97	1.55	**
Changing rate of tastes and preferences of your customer	4.16	1.43	

* indicates significant difference between businesses with a website and without website $p<0.05$
** indicates significant differences between businesses defined as customizers and mass producers $p<0.05$

Analysis

Respondents were categorized into two groups based on level of customization. 62% (n=35) of the respondents were defined as high-level customizers who indicated that over 50% of their products were customized. Those companies who customized less than 50% of their products were defined as mass-producers (n=21).

The results showed that companies with websites (n=28) operated at a high level of mass production, with established production processes that were not altered for customization. Companies with a high level of mass production design products around a standard base and repeatedly manufacture the product F $(1, 52) = 6.40$, $p<0.05$. Though production processes were not changed for customization, customization occurred prior to the beginning of production.

Companies with websites were more likely to use more computer technology including; Computer Aided Design (CAD) F $(1,53) = 6.06$, $p <0.05$, Electronic Data Interchange (EDI) F $(1,52) = 6.56$, $P<0.05$, and decision support systems $F(1,50) = 4.17$, $p<0.05$. They also had a significantly larger number of employees that use electronically controlled technology in their jobs and used shared databases. These mass producers also indicated that consistent standards for hardware and software in the textile and apparel industry made technology implementation easier. Companies with websites were less likely to offer customized products.

Companies with both web sites and a higher level of mass production placed significantly more importance on the copyright or patent of new ideas. In contrast, companies with a high level of customization indicated that offering design services and making rapid design changes were more critical than the companies with a higher level of mass production. Highly integrated channels of distribution were found at companies with websites F $(1,49) = 4.97$, $p<0.05$.

Companies without websites focused more on manufacturing processes that are made-to-order F $(1, 52) = 8.14$, $p<0.05$. Companies with a higher level of customization indicated that their market share F $(1,41) = 5.62$, $p<0.05$ and their ROI's were significantly higher F $(1,37) = 5.41$, $p<0.05$ than their competitors. Most perceived a very rapid rate of change for customers' taste and preference, but a more

stable rate of change due to operating processes and government regulations. However, the business environment overall was considered less predictable.

Companies with higher levels of customization significantly agreed that their customized products were more profitable than their standard products as they were able to accommodate customer requests for size, fabric, or style, and could track the product during the manufacturing process F $(1,50) = 6.39$, $P<0.05$. Most of the products were designed to end-user specifications.

Conclusion and Recommendations

Minnesota has a very diverse textile and apparel industry with little organized support. This is similar to the findings shared in the Michigan apparel and textile needs assessment (Lee, Sontag, & Slocum, 2002). There is a wealth of expertise in customized products, so the potential for the development of mass customization is strong. This is illustrated in the following comment, "Our products are 100 % customer driven designs. We carry almost no inventory. We switch to our 'stock' products in between custom orders in order to keep our people working. The 'stock' products give us stability. The bulk of our revenue comes from custom products." This was typical of the comments that respondents added to the questionnaire. Some manufacturers may want to consider developing products that can be customized with modular components or after purchase by the consumer. This would add efficiency to current methods of one-of-a-kind customization to increase options that would support a move towards mass customization.

Minnesota textile and apparel manufacturers should consider the increased and strategic use of computer technology, and the development or expanded use of a website to build potential markets. Improved data tracking systems could be used to identify consumer orders and preferences, production processes, and financial performance. Efficiencies can be developed in production processes with the use of

CAD, even for smaller companies. For example, this respondent could be supported to adopt computer technology, "In a nut shell, I make really cool stuff for nice, normal people with average budgets. All of my items are sold through word-of-mouth and referrals. Though I will never make the Fortune 500, I love the things I make, and my customers are thrilled to have unique and affordable items that didn't come off an assembly line." Particularly for textile and apparel manufacturers in rural communities, helping to develop competitive advantage with a better understanding of computer technology and product development will strengthen these businesses.

While a profile or needs assessment of the textile and apparel industry of each state will be unique, they are likely to be facing similar issues. The results of this study can be used to validate similar experiences in other states. To remain competitive and grow, the Minnesota textile and apparel industry must be prepared to take advantage of their customization strengths, develop their use of computer technology, and decide how they will respond to the needs of the consumer.

References

Access Minnesota Main Street Curriculum. (1994). University of Minnesota Extension Service. Web siteAvailable: www.extension.umn.edu/mainstreet.

Davis, S.M. (1987). Future perfect. Reading, MA:Addison-Wesley.

DeLong, M.R., Gahring, S., Bye, E.K., & Johnson, K.K.P. (2002). E-Commerce training to aid rural small business development. Journal of Family and Consumer Sciences, 94(3), 33-38.

Dickerson, K., Dalecli. M., & Meyer, M. (1991). A state apparel industry needs assessment:Special concerns for rural economies. Clothing and Textiles Research Journal, 9(2), 37-44.

Duray, R., Ward, P., Milligan, G., Berry, W. (2000) Approaches to mass customization:Configurations and empirical validation. Journal of Operations Management 18, 605-625.

Fralix, M.T. (2001). From mass production to mass customization. Journal of Textile and Apparel Technology and Management, 1(2), 1-7.

LaBat, K. & Sokolowski, S. (1999). A three-stage design process applied to an industry-university textile product design project. Clothing and Textiles Research Journal, 17 (1), 11-20.

Lee, S. & Chen, J. (2000). Mass-customization methodology for an apparel industry with a future. Journal of Industrial Technology, 16(1), 1-8.

Lee, Y., Sontag, S. & Slocum, A. (2002). Michigan apparel and textile manufacturing industry. Journal of Textile and Apparel, Technology and Management, 2 (3), 1-11

Loker, S. & Oh, Y. J. (2002). Technology, customization and domestic production: An apparel and sewn products industry study summary. Ithaca, New York: Cornell University, Department of Textiles and Apparel.

May-Plumlee, T. & Little, T. (1998). No-interval coherently phased product development model for apparel. International Journal of Clothing Science and Technology, 10(5), 342-364.

McDowell, J. & Hester, S. (1986). Assisting small apparel and textile manufacturers in New York State:The potential for university-based programs. Clothing and Textiles Research Journal, 5(1), 42-46.

Midwest Textile & Apparel Industry Directory. (1999, September). Iowa State University, University Extension PM 1787.

Minnesota Department of Trade and Economic Development. (2001). 2000 Annual Export Statistics. St. Paul, MN: Author

Pine, B.J. (1993). Mass customization. Boston:Harvard Business School Press.

Regan, C., Kincade, D., & Sheldon, G. (1998). Applicability of the engineering design process theory in the apparel design process. Clothing and Textiles Research Journal, 16(1), 36-46.

ReferenceUSA. (2001). Business Database [Data file]. Available from infoUSA, http://www.referenceusa.com/bd/QS_BD.ASP?si=61620209089772&searchPage=QS_BD.ASP

Shea, K. (1999, September-October). The power of electronic commerce: Helping to invigorate rural America, Minnesota Technology p.47-48,

Sheller, H. & Rabon, L. (1997, November). Mass customization affords product variety. Bobbin, 43-52.

Taplin, I.M. (1999). Continuity and change in the US apparel industry: A statistical profile. Journal of Fashion Marketing and management, 3(4), 360-368.

Tedeschi, B. (November 5, 2001). E-Commerce Report. Wall Street Journal, C1.

US Office of Technology Assessment. (1987, April). The US textile and apparel industry: A revolution in progress-A special report (OTA-TET-332). Washington, DC: US Government Printing Office.

Wu, W., Anderson, L.J., & Ulrich, P.V. (1998). An investigation of consumer interest in co-design for mass customization of apparel. Proceedings of the International Textile and Apparel Association, Dallas, TX., 38.

J
T
A
T
M