

# A MULTIPLE CHOICE SYSTEM FOR DESIGNING KNITTED FASHION GARMENTS

J. Peterson, J. Larsson  
Swedish School of Textiles  
University College of Borås  
501 90 Borås SWEDEN

## ABSTRACT

During the last 20 years there has been a dramatic technical development in the production of flat knitted fashion garments. This has made it possible to rationalize design and production of knitted products in a way that it's possible to make a knitted garment ready made directly in the knitting machine, with a minimum of after coming processes. Starting point is a business model with the knitting machines located in the store. The customer takes an active part in the design process and garments are customized to fulfill actual demand. The objective of this paper is to develop a model for a "multiple choice" design system. The objective is also to combine the complete garment knitting technology with the area of mass customization and show how this could be implemented in the business of fashion products. The result is an overview of the area of mass customization, complete garment knitting technology and the Knit On Demand business concept. A multiple-choice system where the customer selects style, pattern, size, color and other features of the garment in order to customize the product is presented. Methodology for this paper is an inductive approach based on a literature survey and research project at the University College of Borås.

## 1. INTRODUCTION

The western economies has moved from the craft era, where everything was produced in one or a few pieces, to the mass production era where the products are produced in large batches and millions of pieces to reach economies of scale. Pine (Pine, 1993) suggested that the mass production paradigm was under threat from a new concept described as mass customization (Davis, 1987), although this concept was anticipated already 1970 by Toffler (Toffler, 1970) in his book *Future Perfect*. This trend is nowadays more visible and with the help of new technology it is also possible for companies to explore the economies of scope. Fashion companies are not excepted from this and have to adapt to customer's behavior. A behavior that is becoming more and more complex due to that fashion buyers of today are increasingly influenced from more information channels than before (Ulrich et al., 2003). A major problem with fashion retailing is that between 30 and 40 percent of the clothes are sold to reduced price i.e. the sell-through factor is between 60 to 70 percent. The reason for this is up-front buying of the products with a high degree of uncertainty in customer demand. When the garments are on the shelves in the shop customer demand has changed and the product must be sold to a reduced price. One problem is that true demand is not visible at the point when the clothes are ordered or produced. In a demand driven value flow the garments are produced near point of sales or in the best case after the product is sold. Then, there is no physically held stock of products, which reduces cost of inventory and release capital that can be used for other activities. By facilitating new production techniques and new sales channels fashion companies will be able to respond to customers shifting demands without becoming

overstocked and have to sell the remaining garments to a reduced price at the end of the season.

The purpose of this article is to present the development of a Multiple Choice System, MCS, for usage in a new business concept called Knit On Demand. In the Knit On Demand concept everything that is produced is produced to customer order and no finished products are held in stock. Customers are also allowed to customize the garments to a certain degree. The customization is done in the multiple choice system where the customer is allowed to choose from a list of pre-engineered options e.g. different color ways, patterns, models, sizes and accessories. The choices are pre-engineered to ensure the quality and to draw benefits from economies of scale.

## **2. METHOD AND RESEARCH QUESTION**

The purpose of this paper is to present a model for a multiple-choice system for knitted fashion products. A system where the customer could select style, pattern, size, color and other features of the garment in order to customize the product is shown. The objective is also to combine the complete garment knitting technology with the area of mass customization and show how this could be implemented in the business of fashion products. Methodology for this paper is an inductive approach based on research project at the University College of Borås, School of Textiles.

## **3. MASS CUSTOMIZATION**

Toffler anticipated (Toffler, 1970) in 1970 that along with new technology there would be a shift in peoples wants and needs. He proposed that companies would be able to produce customized goods on a mass basis and make a profit out of it. Companies around the world has recognized the need for individualizing their products as a strategy not to lose customers to other firms (Gilmore and Pine II, 1997). Mass production is organized around production of large batches, long runs and economies of scale. The product is pushed to the market and is presumed to fit all needs in a supposedly homogeneous marketplace. Consumers at the end of the value flow will choose from a number of products that the retailer has placed on the shelf. In a mass customization value chain the customer is integrated further upstream in the value flow, as early as in the design phase of the product, hence offering the customer a wider variety of options and the possibility to customize the garments. Ordinary production equipment can be used in textile value chains to produce mass customized garments but there is a need for new ways of interpreting customer demand, and also a need for new ways in planning the production (Ulrich et al., 2003). In the work with customizing the company's products there are certain levels to be developed to enhance the degree of customization. At the first stage customers could personalize standard items and at the last stage fully customized products are offered that consists of modular products. Such working methods might also be applicable in knitting technology. By integrating standard or upgraded production techniques with modern information technologies that enables individualization of standard products a consumer driven process is developed.

### **1.1 INFORMATION TECHNOLOGIES**

To get a mass customized value flow to work properly it has to be supported by some sort of information technology that allows the producing company to communicate with the customers, otherwise the customer will not be able to express their needs and the company will never know what the customer wants, much as it is today. One technique frequently mentioned in literature (Ulrich et al., 2003, Anderson-Connell et al., 2002) is body scanning,

developed by TC<sup>2</sup> (TC<sup>2</sup>, 2007) which allows companies to take exact measures of the customer and then producing garments that fit the customer perfectly. Levi's has their own system called Intellifit. Such technique combined with new manufacturing technologies such as the Complete Garment knitting technology would allow manufacturers to utilize economies of scale and still produce one off garments. A textile demand flow could also gain from recording and storing consumer data, either in a database or if the customer keeps the data by them selves e.g. in a smartcard. The customer can store the colors, sizes, measurements or models of his or hers preference in the smartcard allowing for faster and more convenient shopping.

## 1.2 Different approaches to mass customization

Gilmore and Pine (Gilmore and Pine Ii, 1997) defined four different approaches to mass customization in 1997 and depending on the technologies enabled in the value flow there will be different levels of mass customization. From the level where the retailer customizes their assortment according to the customer's wants and needs to the level of complete customization or integrated design. Figure 1 illustrates the four different approaches that companies might take to mass customization. These four approaches has been somewhat modified to fit an apparel mass customization value flow.

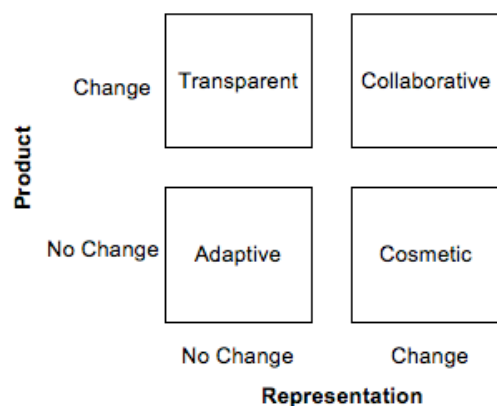


Figure 1: Different approaches to Mass Customization (Gilmore and Pine Ii, 1997)

### 1.2.1 Cosmetic customization

Cosmetic customization is simply to present the product line differently to different customer. Anderson-Connell et.al. (Anderson-Connell et al., 2002) has modified this approach to the concept of expanded search and expanded selection and is the first line of integrating the customer in the value flow. The concept of expanded search and selection allows the customer to choose from a wider range of products, products that are usually not available in an ordinary retailer but by knowing the customers preferences the company is able to customize their assortment.

### 1.2.2 Collaborative customization

This approach to customization involves a dialogue between the customer and the company. The company is expected to fulfill customer demand and help the person to customize a garment to the actual ideas and needs from the customer. Four versions of collaborative customization are defined: design options; totally custom; co-design and clothes clones.

- Design options – Allows the customer to choose from a menu of design components (buttons, cuffs, pockets, zippers, colors and patterns) to create a customized garment made from standard sizes and models. The customer then gets visual feedback from the system, e.g. 3D visualization. All of the options in the library have been pre-engineered so the company has control over the quality and production process. The benefit for the company is that they are able to respond to customer demand in a far more accurate way.
- Totally custom – Customers are allowed to fully design the garments choosing specific fabrics, colors and trimmings. The company tries to fulfill the exact needs of the customers. Producing totally customized garment is most usual for special occasion garments such as wedding dresses, jackets and suits. Swimwear is produced in this way although in a less advance degree. New 3D CAD systems such as Lectra, Eneas' 3D-visualizer, Shima Seki SDS-One and Browzwear's 3D-Stitcher allows instant 3D-visualization of the garment down to course level and in some cases (Shima Seiki) picture perfect simulation down to fiber level. Both design options and totally custom requires the customer to be comfortable with choosing from a multiple-choice system or understanding the properties of a CAD-system.
- Co-design – For customers that want to customize fit and size of the garment. This option is very much like design options and the customer's choices could be limited to a menu in a multiple-choice system.
- Clothes clones – Some customer wants multiple versions of their favorite garment and when the garment is worn out, they want a similar one. This can be a certain color or a certain fit that is no longer available in the stores (Anderson-Connell et al., 2002).

### ***1.2.3 Adaptive customization***

Adaptive customization offers one standard but the product is designed so that the customers can alter the products themselves. The customer wants their products to perform in different ways depending on the situation. This approach is not very common in mass customization of clothing because people tend to buy different clothes for different occasions and purposes and do not expect a sweater to be flexible enough to be worn it both to the gym and to the dinner with the in-laws (Gilmore and Pine Ii, 1997).

### ***1.2.4 Transparent customization***

When a company provides unique goods or services without letting the customer know that the product has been customized for them. Companies observe customers and make the product according to the explicit or implicit demand of the customer (Gilmore and Pine Ii, 1997).

## **1.3 Production of mass customized products**

One of the benefits of mass customization is that no finished goods are held in inventory since everything is produced to specific customer orders. Many companies' tries to reduce products held in inventory and thereby set free capital to be invested to a better interest or used in other activities in the company. A problem in several business areas is that a lot of products only sell a few per year and the cost of holding inventory is too high. In a bookstore for example

one copy of a book can be on the shelf for years. Amazon has solved this by "Print on Demand" meaning that the book is stored digitally and printed when the customer orders it. The book is then sent to the customer by mail. Of course, this working method has its limitations, any format is not possible so sometimes the books has to be edited to suit the system and the technology used is still quite expensive but as volume goes up, the cost goes down (Anderson, 2006).

In a textile demand chain of mass customized knitted garments everything is produced to order and the inventory is held virtually in a database. A relatively new knitting technology called Complete Garment (Hunter, 2004) is used in the Knit On Demand concept and the technique is able to produce garments seamless in one piece thus limiting the need for costly but mostly time consuming after-coming cutting and sewing processes. Figure 2 explains the development of knitting technology (Choi and Powell, 2005). This technology also reduces lead-times drastically through the factory much due to the fact that processes are eliminated and places where semi finished products and finished goods can pile up is held at a minimum.

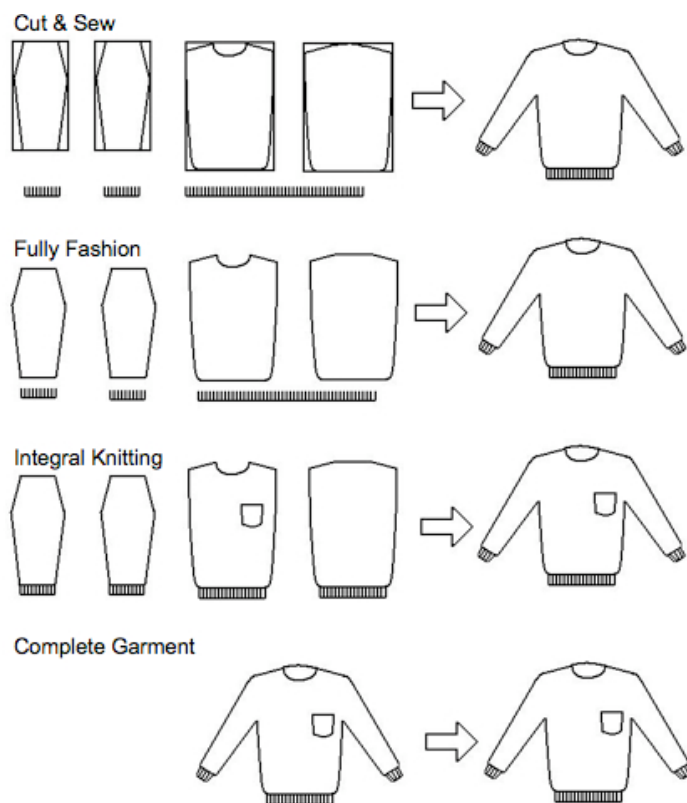


Figure 2: Development of knitting technology from Cut and Sew to Complete Garment.

#### 1.4 Customer behavior

Customers are not looking for more options in shopping, they are more interested in personalizing their apparel (Anderson-Connell et al., 2002). In a customer survey conducted in the Knit On Demand project concluded that 100 percent of the respondents below 18 years of age wanted to customize their clothes. 66 percent in the age group 19-27 and 60 percent in the age group 28-37 found the interesting and was willing to customize and purchase a garment. The problem in mass customization is mainly fit and probably also the reason why many customers fail to purchase garment. In traditional retailing customers make their choices based firstly on color, then on style (fit, size) and lastly on fabric, sight first then sense (Watson, 2007) and most likely people area acting in the same way on the Internet. In

the Knit On Demand concept the multiple-choice system will be complemented with size samples to get around the problem with the fit. Another aspect to mass customization and customer behavior is the notion of mass confusion as a result of companies trying to satisfy customers by an extended number of choices. Customers tend not to prefer a long list of choices presented to them but rather to express their needs and wants. Using a fitting module that automatically provides the customer with the correct sizes and fits might help in such a situation because the customer would not have to enter their own measures. Satisfaction with the configuration process can be illustrated with an inverted U-shaped curve (figure 3) which means that mass confusion appears at a specific degree of customization (Franke and Piller, 2002).

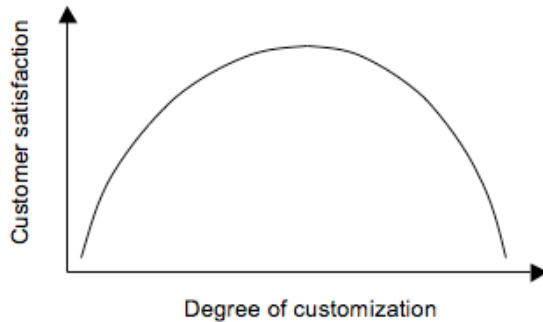


Figure 3: Mass customization – Mass confusion

## 2. MULTIPLE CHOICE SYSTEMS

Multiple choice systems or configuration systems is the core communication tool, both for new and old customers. Systems like these are also known as configurators, choice boards, design systems or tool-kits. In this article we will refer to it as a multiple choice system because the customers will be allowed to choose from a list of pre-engineered choices and not making any designs of their own. The system is the interface between the customers and the companies so a lot of aspects have to be considered when designing it, not only technical specifications. The success of such a system is not defined only by its technological capabilities, how well it operates and matches the selling environment and how easy it is to use is equally important as well as the integration in the companies profile. (Franke and Piller, 2002). Multiple-choice systems do not have to be based on software although most of the existing ones are. In order for a multiple-choice system to work properly and provide the customers with enough feedback to decide on a purchase, three components are needed:

- The *core configuration software* presents the choices to the customer and guides the customer through the process of designing the product.
- A *feedback tool* presents the choices the customer has made in the configuration system, in most web-based systems the feedback consists of a visualization of the product and the price
- *Analyzing tools* finally translates the customer's choices to a bill of material, production order and production schedules. The analyzing tool translates a customer specific order into lists of material, production orders and data to the knitting machine. The analyzing tool also sends data about material usage and other logistic related figures to the ERP and MRP systems.

There are a number of steps in a purchase that has to be considered when building a multiple choice system, as mentioned above, the success of the system is not dependent only on the configuration of the product. Figure 4 explains the steps of a purchase and the necessary capabilities of the system in each step.

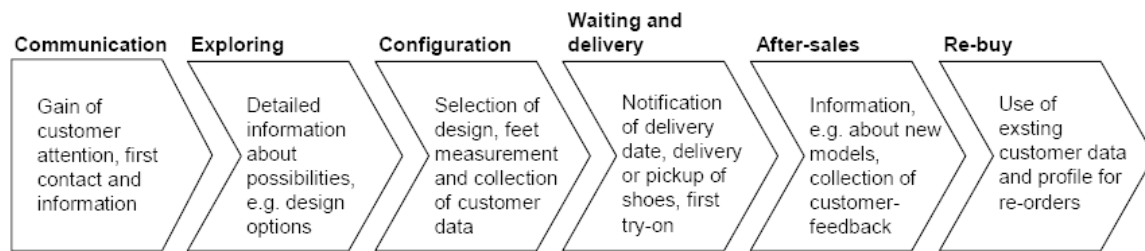


Figure 4: Steps in a purchase and the necessary capabilities of the multiple choice system (Franke and Piller, 2002).

Shopping in this way is not the normal way of shopping. In an ordinary retailer the customer is allowed to see the finished garment before purchasing it. In the Knit On Demand concept the customer has to make their minds up from trying on size samples, feeling fabric samples and looking on a 3D-visualised garment on a computer screen. Creating an environment where the customers feel safe includes three main tasks besides the design part. The user has to learn what is possible with the system, he or she has to try the different possibilities and learn from the errors they make thus making it important to make the system as simple and easily overviewed and navigated as possible. A system also has to allow for comparing different results. Because of its central role the multiple choice system is the most important entity in a value chain for mass customization and it is important for the developers to consider all the aspects of a purchase, not only the technical issues.

## 2.1 Visualization and feedback

For the customers to make up their minds about the purchase they have to believe that what they put into the multiple choice system will come out in the other end of the process. The visualization of the product has to be dynamic meaning that the changes the customer makes will appear immediately on the screen. As mentioned above the concept store will be equipped with size samples and swatches of colors and fabrics for the customers to choose from make the selection process more convenient for the customer and thus shortening the process (Piller et al., 2003).

## 3. CASE STUDY: KNIT ON DEMAND

Knit On Demand is a business concept based on the manufacturing technology of complete garment production. The customer will be involved in the design process of the garment and could choose between alternatives of style, material, color, structure sizes and attachments. Figure 5 presents a draft to how the concept store will look like. There are two levels in the Knit On Demand concept.

1. Design In Shop – If a person wants to design his/her own garment a shop assistant guides them to a personal design of the garment using the multiple-choice system. This will not be a free design in the sense that the customer can create a new product without limitations of style, color, structure and size, but more of a customization of the garment. Choices concern style, material, structure, color, size, and attachments. If the design is accepted it generates an order to the production unit of the shop.
2. Designers Place – Established designers and designers on their way up are allowed to exhibit and sell garments in the concept store. This level of the concept works as an ordinary store with ready made garments on the shelves in the shop. The garments are then produced in the same production system as fully customized garments. One of the key issues of Designers Place is that it enables the knit production unit of the concept

to maintain a high efficiency. When a product is sold it immediately generates an order to the knit production unit and thereby maintains a high efficiency in the production unit even if there are limited orders from the Design In Shop part of the store.



Figure 5: Design in shop concept

### 3.1 Customer interface

The multiple choice systems main task is to guide the customers through the list of choices and present the result in such way that the customer is able to make up his or hers mind about the purchase. Figure 6 is a draft of the customer interface. The customer configures the garment and enters personal data into the system.



Figure 6: Draft of the customer interface

The customer is allowed to choose from models, sizes, color-ways, embroidery and attachments, depending on which kind of garment he or she buys.

### **3.2 Administration interface**

The system of course has to be usable for customers but it is almost equally important that it is usable for the administrator or the shop assistants otherwise they will not keep the system updated with colors and models. The goal is to connect the system with the material resource planning (MRP) system that keeps track of the inventory levels; in this way the list of colors that the customer can choose from is automatically updated. Figure 7 illustrates a draft to the administrator interface.

### **3.4. Integration with business systems**

New information technology makes it possible to easily share information throughout the supply chain. Connecting the multiple choice system to an ERP or MRP system will not only make it easier for the company owning the system to keep track of their inventory, sales and service level but also to provide real time information to suppliers and to customers.

### **3.5. Analysis system**

In order for the selling company to analyze the system an analysis tool has to be created. The functions of the analysis tool is the following:

- The number of times the colors of a garment is changed,
- The number of times the model is changed
- How many times do customers enter the system and how many times do they finalize a purchase? This is a method to measure lost sales.

## **4. FUTURE RESEARCH**

In the system a lot of data and statistics could be used to study customer behavior to be a platform for further development of the system to make the Knit On Demand concept more demand driven and profitable. This method with combining mass customization with the complete garment knitting technology is relative new method of fashion retailing and not much research has been done on this subject. How the system can be further integrated with other functions in the supply chain such as MRP- and ERP-systems and logistic system also adds value to the research project. The quality aspects of such a multiple-choice system is an important factor, how do the company assure that the system is continually upgraded with new models, colors and patterns? Another quality aspect is how to ensure the quality of the garments. The garments are pre-engineered to ensure quality but how will it work in reality? Could the multiple-choice system be directly connected to the knit production system is another issue to further investigate in the future.

## **5. CONCLUDING DISCUSSION**

Textile and fashion products are commonly produced and brought to the market using mass production methods and tools. The supply is often organised around large batches, long runs facilitating economies of scale. With this concept there are limited possibilities for the end customer to adapt his own design to the product in order to get a more individual garment. Companies around the world have recognized the need for individualizing their products as a strategy not to lose customers to other firms. New technology such as the Internet and the Complete Garment knitting technology has also made it possible to reach economies of scope using scale-economy production methods. Mass customization allows the customer to have a

certain influence over the design of the product, some allow for total customization and some only present a wider variety of choices to the customer. The business model Knit On Demand is built on the concept of mass customization and the complete garment knitting technology. In the Knit On Demand concept store the customers are presented to a multiple-choice system with the main purpose to guide the customer through a list of choices and present the result so that the customer is able to make up his or hers mind about the purchase. It is very important to present the garment to the customer in such way that the picture that the customer has in his or hers mind is the same or enough the same as the picture on the screen. In order to administrate the system an administration interface connects the system with the material resource planning (MRP) system in order to manage the inventory of yarns and attachments. Another issue is how long the customer is willing to wait for delivery of the garment? The target is that the customer can bring the garment home the same day it is designed but if there is a queue that might not be possible.

## 6. REFERENCES

- ANDERSON, C. (2006) *The Long Tail: Why the future of business is selling less of more.* - 1st ed., New York, Hyperion Books.
- ANDERSON-CONNELL, L. J., ULRICH, P. V. & BRANNON, E. L. (2002) A consumer-driven model for mass customization in the apparel market. *Journal of Fashion Marketing and Management*, 6, 18.
- CHOI, W. & POWELL, N. B. (2005) Three Dimensional Seamless Garment Knitting on V-bed Flat Knitting Machines. *Journal of Textile and Apparel, Technology and Management*, 4, 33.
- DAVIS, S. M. (1987) *Future Perfect*, Massachusetts, Addison-Wesley Reading.
- FRANKE, N. & PILLER, F. (2002) Configuration Toolkits for Mass Customization. Munich, Germany, Des Lehrstuhls für Allgemeine und Industrielle Betriebswirtschaftslehre der Technischen Universität München.
- GILMORE, J. H. & PINE II, B. J. (1997) The Four Faces of Mass Customization. *Harvard Business Review*, 75, 91-101.
- HUNTER, B. (2004) Complete Garments, Evolution or Revolution. *Knitting International*, 111, 2.
- PILLER, F., BERGER, C., MÖSLEIN, K. & REICHWALD, R. (2003) Co-Designing the Customer Interface: Learning from Exploratory Research.
- PINE, B. J. I. (1993) *The New Frontier in Business Competition*, Boston, Harvard Business School Press.
- TC2 (2007) 3D Body Scanner. Raleigh, North Carolina.
- TOFFLER, A. (1970) *Future Shock*, New York, Bantam Books.
- ULRICH, P. V., ANDERSON-CONNELL, L. J. & WU, W. (2003) Consumer co-design of apparel for mass customization. *Journal of Fashion Marketing & Management*, 7, 398-412.
- WATSON, K. (2007) London, Industry Forum.