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## ***Mass-customization Methodology for an Apparel Industry with a Future***

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## Introduction

In today's apparel market, consumers desire to personalize the style, fit and color of the clothes they buy (Apparel Industry: Consumer customization, 1998; SRI Consulting, 1997). According to Kurt Salmon Associates' 1997 Annual Consumer Outlook Survey, 36% of consumers are willing to pay up to 15% more for customized apparel and footwear, and will wait up to three weeks to receive their customized product (Apparel Industry: Consumer customization, 1998). This report, however, does not negate the values of low cost and fast delivery in the con-

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sumer market. Most of today's consumers require high-quality customized products at low prices with faster delivery (Cameron, 1998). With this sort of consumer interest in mind, the concept of mass customization emerged in the late 1980's.

## Concept of Mass Customization

Mass customization is a hybrid of mass production and customization. In his book, *Mass Customization*, Pine (1993) defines mass customization as "the mass production of individually customized goods and services" (p. 48). Given the changing characteristics of today's consumer interests and industrial competition, mass production systems cannot satisfy both manufacturers and consumers; however, a mass customization system may achieve both manufacturer and consumer satisfaction, providing a low-cost customized product. Pine stated that the prerequisite of implementing mass customization is the application of advanced technology, such as the flexible manufacturing system, computer-integrated manufacturing, computer-aided design, and advanced computer technology. Pine explained that using these technologies in the practice of mass customization will shorten product-life and development cycles as well as allowing manufacturers to respond more quickly and flexibly to changing consumptive drives. Finally, consumers will have access to a variety of relatively low-cost, high-quality, customized products while manufacturers can reduce excess inventory and markdowns.

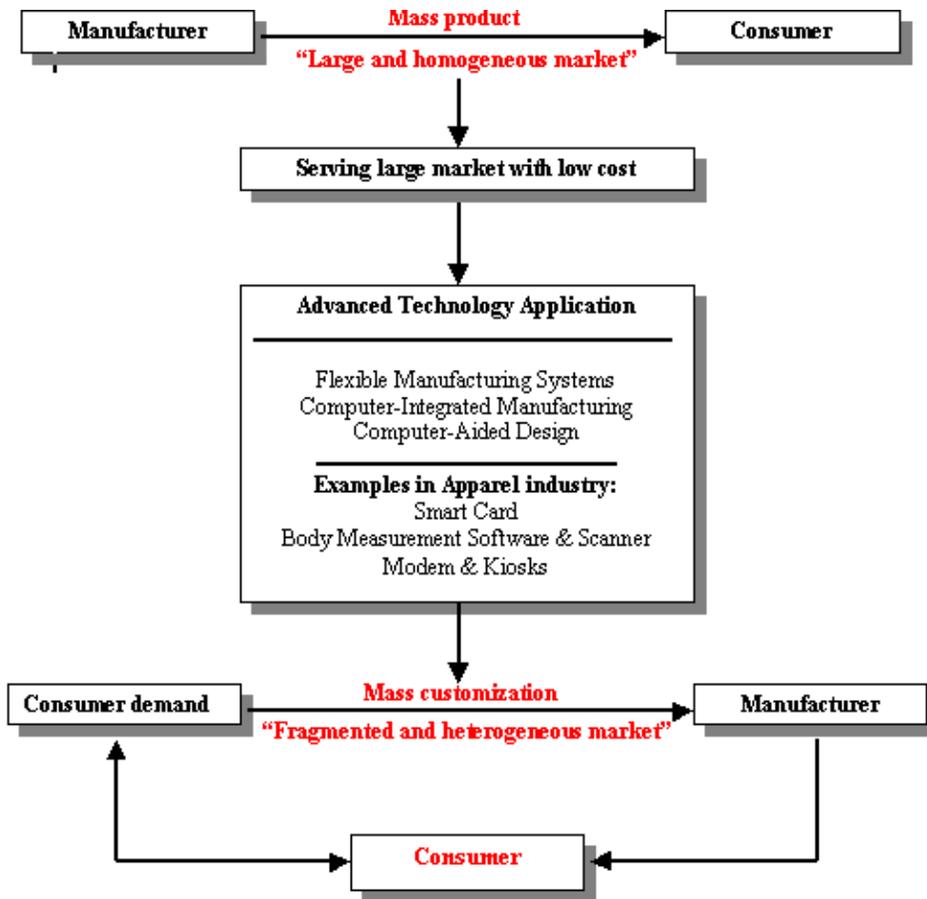
Fig. 1 (page 3) shows the concept of mass customization as defined by

Pine. This mass customization system adopts the concept of serving a large market with low cost products created through mass production, and the application of new technology facilitates manufacturer responses to consumer drives for custom garments. Pine explained that, while the market of mass production is "large homogeneous market", the market of mass customization is "fragmented and heterogeneous."

## An Example of Technology Applied to Mass Customization in the Apparel Industry

In the apparel industry, several new technologies have helped mass customization operations. First of all, precise measurements of individual consumers are required to customize apparel products. Usually, in the store, a trained sales person processes the body measurements. A consumer can be measured by hand, by laser body scanner, or by video camera. Then, body measurement software modifies a stored pattern prototype by using specific individual measurements. For example, a trained sales person takes the customer's measurements at certain body points, and these measurements then are entered into the system, which consequently adjusts the size of matching points on the pattern prototype. Alternatively, a computer may generate a digital image using a video image of the consumer wearing a body stocking, and then use pattern generation software to convert measurements from the image to a specific pattern (Chase, 1997). The most highly-developed measurement device measures the entire body three-dimension-

Figure 1. Mass Customization Concept



ally using a laser. The consumer is scanned while wearing his/her street clothes. About a minute later, a printout of the image is made. Then, the measurement information is stored in a central database or on a smart card. The consumer uses this smart card to select the garment of choice and the pattern is adjusted automatically to fit the measurements made in the store (Bobbin, 1997).

### Overview of the American Apparel Industry

Labor-intensive apparel industries require workers for every process. Traditionally, apparel manufacturers have used the bundle system, a method of passing the pieces of the partially finished garments from one set of laborers to the next, restricted by rigid hierarchical divisions. However, rapid dynamics of consumer desires in the fashion market coupled with the global competitiveness of low-wage-rate

countries has diminished the effectiveness of this system. By focusing on producing the maximum number of units in a given period of time, the bundle system has caused problems that include excess inventory, a long lead time, and low quality (Black & Chen, 1995).

Thus, apparel manufacturers have begun to try JIT (Just-In-Time) or QR (Quick Response) concepts to eliminate excess inventory, long lead time, and low quality in traditional manufacturing systems (Black & Chen, 1995). Additionally, apparel industries have invested in computer systems to control design, cutting, embroidery, and sewing information (Taylor, 1992; Kalman, 1997). With these earlier advancements in manufacturing technology, apparel industries found new niche markets for the made-to-measure garment (Harris et al., 1992). Now, rather than just niche markets, customization may become a broad

trend for apparel industry production and retail (Burns & Bryant, 1997).

### Purpose of this Study

The purpose of this study is to study how apparel industries practice mass customization and what dynamics of the industry are changed by the impact of mass customization. Finally, this study will present a model explaining the effect of mass customization on the apparel industry. For this purpose, a literature review is applied to real examples where mass customization is in practice in the apparel industry.

### Effects of Mass Customization Practices on the Apparel Industry

#### Mass Customization Practices

Several researchers have mentioned about the nuances of mass customization practices in the apparel industry. Burns and Bryant (1997) explained that mass customization in this industry is processed by computer technology. These processes employ four basic steps. First, a trained sales representative measures the customer with the assistance of a computer. Second, the salesperson enters the measurement data into a computer and alters the garment specifications according to the customer's preferences encoded in this data. Third, the adjusted measurement is sent to a fabric-cutting machine in a factory to create the customized garment piece. Fourth, finished pieces of the customized garments are labeled with a bar code, assembled, and then retailed. Processes such as these use computer technology to connect the consumer with the retail store as well as the apparel factory.

Lee (1994) described body scanning and digitized image uses in mass customization practices, stating that the customer is measured three-dimensionally, and through the digitized image on a kiosk or video screen, the customer can see whether the style (which they select) fits their preferences.

Anderson et al. (1997) created a model of mass customization for the apparel industry. Based on consumer research, they indicated that digital

information and new technology in the process of manufacturing will develop customized apparel with four options: “expanded selection/search;” “design option;” “co-design;” and “total custom.” In the “expanded search,” intelligent search capabilities enable a customer to access various manufacturers’ product lines. In the “design option,” the next level above the “expanded search,” the customer selects from manufacturer/retailer’s designs, sizing, style options, style details, color, and fabric to create the designed garment, through computer aided design (CAD) and digital printing. “Co-design” offers additional personal fit through the ad design manager, based on the “design option choices.” Finally, in “total custom,” the customer communicates his or her own designs to manufacturers or retailers in a digital format.

The effects of mass customization in the apparel industry are presented in Figure 2.

**Examples of Actual Application of Mass Customization in the Apparel Industry**

There are three major examples of the application of mass customization techniques in apparel industries.

**(1) Custom Foot Inc., Florence, Italy**

The Custom Foot offers a new concept in fitting customers with shoes (Justin, 1997). The selection of shoes collected on the shopping floor of Custom Foot is available for selection of style only. After a customer chooses a style, precise measurements of the consumer’s feet are taken using a computer scanner in the store, which takes about 30 seconds to register different sizes and widths, distinguishing the right foot from the left. Consumers then choose their shoe style from swatches of different materials

presenting various colors and textures (including heel options). About 160 display “models” provide style guidelines. Customers’ measurements and choices of style, color, and material compose an order that software translates into Italian and sends to Custom Foot’s Florence office by modem. The orders are distributed among six factories in Italy, and one in America. Production and delivery takes about three to four weeks, providing customized footwear for a cost of about \$180 per pair (see Figure 3 on page 5).

**(2) Levi Strauss in Mountain City, TN, U.S.A (Abend, 1996; Oleson, 1998)**

In 56 original Levi’s stores across the United States and Canada, Levi Strauss & Co. is using mass customization with its Personal Pair women’s custom fitted jeans program, and will begin providing men’s custom jeans in the near future, as well. Fig. 4 shows the process of making customized jeans.

In the store, a trained sales person takes four initial measurements of the waist, hip, inseam, and rise. These measurements are entered into the computer system, which suggests a prototype-test garment. The consumer tries the prototype on and fit modifications are made in any of four areas of the garment, based on the consumer’s preferences (such as a tighter fit, looser fit, shorter, and longer). Two or three prototypes are usually required to find the perfect fit for the customer. Having specified these processes, the order is sent via modem to Levi Strauss in Mountain City, TN. The cost of this process comes out to about \$65 a pair (around \$15 more than buying directly off-the self), with about three weeks needed for production and delivery (see Figure 4 on page 5).

**(3) Second Skin Swimwear, Juno Beach, FL, U.S.A. (Rabon, 1996)**

In the Second Skin Swimwear store, a customer begins every step in buying customized swimwear with trained salesperson. First, by trying on sample suits (20 one-piece suit styles,

**Figure 2. The effects of mass customization in the apparel industry**

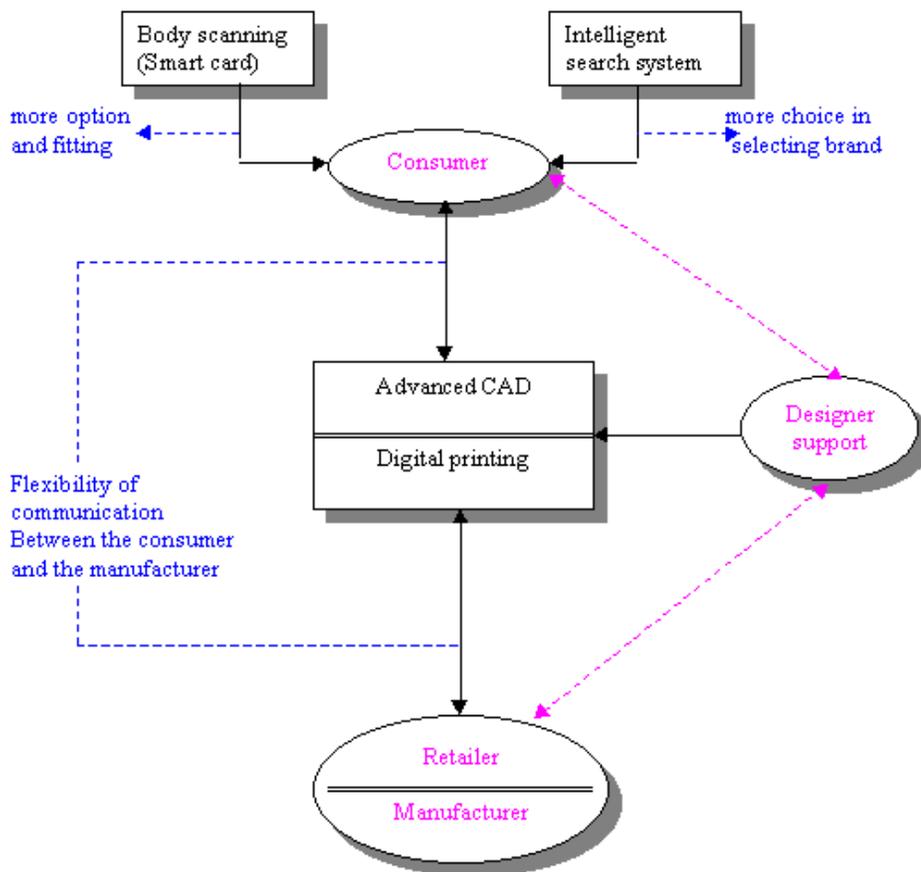


Figure 3. Example of Custom Fit

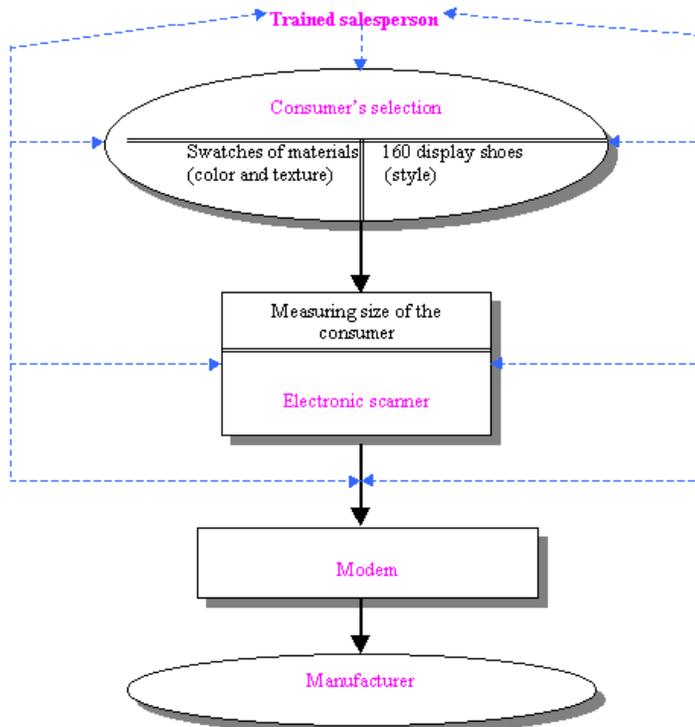
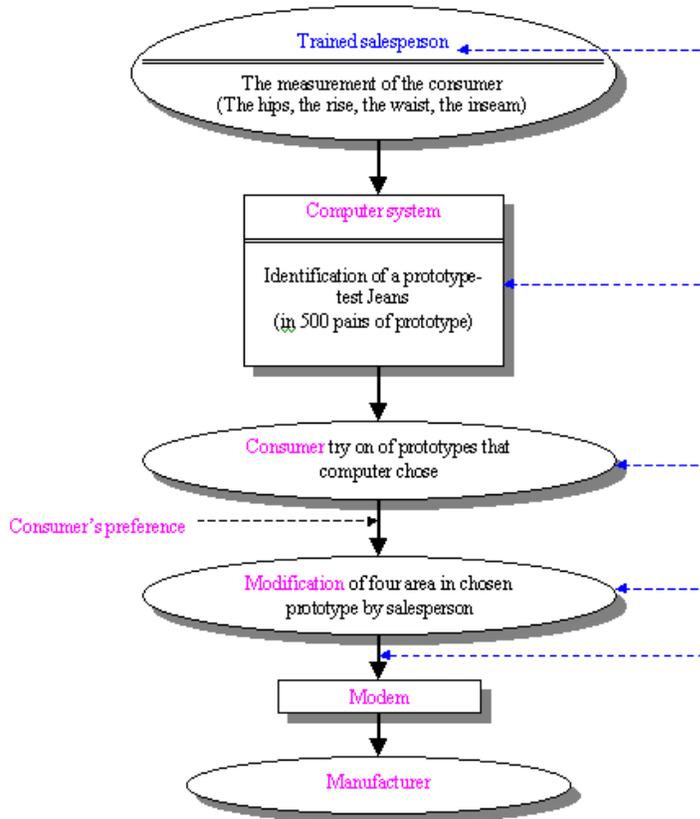


Figure 4. Example of Levi-Strauss & Co. (In store activity)



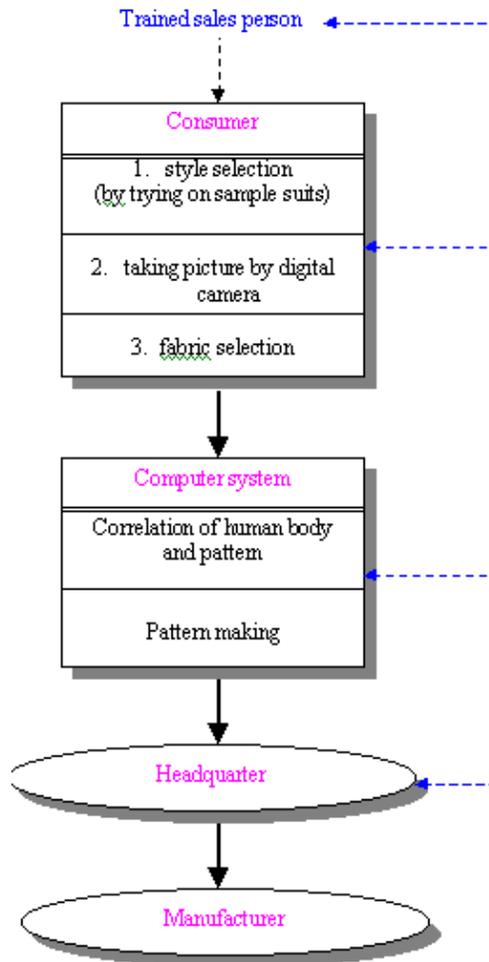
and a combination of about 20 top and bottom styles), the customer finds the preferred style. After that, a digital camera scans the customer for about two minutes, and then the customer chooses the preferred fabric. This whole “Digifit” process takes about one hour. All information related to this process is recorded by a trained salesperson and entered into the store computer system to eventually be sent by modem to Second Skin’s headquarters in Juno Beach, FL. This recorded information is also stored in a disk and downloaded at the factory. The delivery time required for completed customized swimwear is less than two weeks, at a price of between \$90 and \$200 per suit, depending on the customer’s add-on preferences (see Figure 5 on page 6).

### Steps toward Mass Customization

Mass customization is new to the apparel industry, and in its processes, following problems need to be resolved for the full implementation of mass customization toward consumers (Scheller & Rabon, 1997):

- (1) Body scanning: Body scanning brings the output of the XYZ coordinates of a physical body, so it must be modified to make its use more practical in aspects of the application of apparel design and pattern.
- (2) Single-ply cutting: In mass customization, manufacturers cut one garment exactly according to consumer preferences. The problem is that this single-ply cutting is more expensive than general cutting systems, and it must be improved in order to accommodate automatic continuous cutting for mass customization.
- (3) CAD system: Despite the AAMA’s (American Apparel Manufacturers Association) new CAD standards, compatibility problems between hardware and software systems from vendor to vendor mar the spread of mass customization through the industry.
- (4) Pattern design: Because commodity patterns must be modified for individual customers,

Figure 5. Example of Second Skin Swimwear



the means by which the pattern is altered is an issue of concern.

To utilize mass customization, manufacturing processes must be flexible, and to be flexible, every step in the manufacturing process must have the ability to react quickly to changes in product design and to changes in consumer interests and needs. After the manufacturer communicates with individual customers and receives the order/fit specifications, individual products are cut and assembled, and the garment is shipped to the customer within about three weeks. In these processes, individual products may have totally different specifications, so the information received for production must be interpreted correctly by each operator in each of the manufacturing processes.

Also, the systems and organizations of manufacturing processes should be changed so they are able to respond to an individual order. For example, in the manufacturing process of Second Skin Swimwear, there is no work in process. The swimsuits ordered are manufactured individually by the company's sewing specialist (Rabon, 1996).

A major concern lies in how the apparel industry can effectively use its existing manufacturing facilities and organizational structures to adopt mass customization. Flexible manufacturing systems are required in mass customization environments; at the same time, these advanced manufacturing systems have been in demand to achieve a better mass production environment. For this reason, there has been some debate regarding whether

these manufacturing systems should be maintained, or whether they should be changed to allow for mass customized products. Pine, et al. (1997) studied these questions in the case of the automobile industry. They stated that a new organizational structure is needed in industry, and that structure should be "a dynamic network of relatively autonomous operating." They also mentioned that, with advanced manufacturing technology, mass customization requires a different organizational structure, rather than the normative bureaucratic structure, for mass production. For more highly-customized products, the industry must consider that manufacturing modules must be flexible and diverse; therefore, the various capabilities of employees contributing to this system must be recognized and utilized to the fullest extent possible.

In present mass customization practices, the apparel industry limits the customized extent of the product market to reduce costs. With mass customization, the styles that customers choose are, to a limited extent, already within a broad style framework prescribed by the manufacturer. For example, at the Custom Foot, there are a limited number of style variations and size ranges. Regardless, there are more choices than what off-the-shelf retailers offer (Justin, 1997). Additionally, Burns and Bryant (1997) stated that, in apparel companies pursuing mass customization, the pattern is based on a "standard body" of the target customer. The "standard" size is adjusted to fit individual consumer specifications.

### Conclusions and Suggestions

Mass customization is not a fiction of the distant future. In fact, mass customization exists in industries besides just the apparel industry, such as the automobile industry and the information technology industry. Although the industries that practice mass customization are not entirely successful in maintaining a low inventory and satisfying all their consumers, new advancements in manufacturing technology will allow

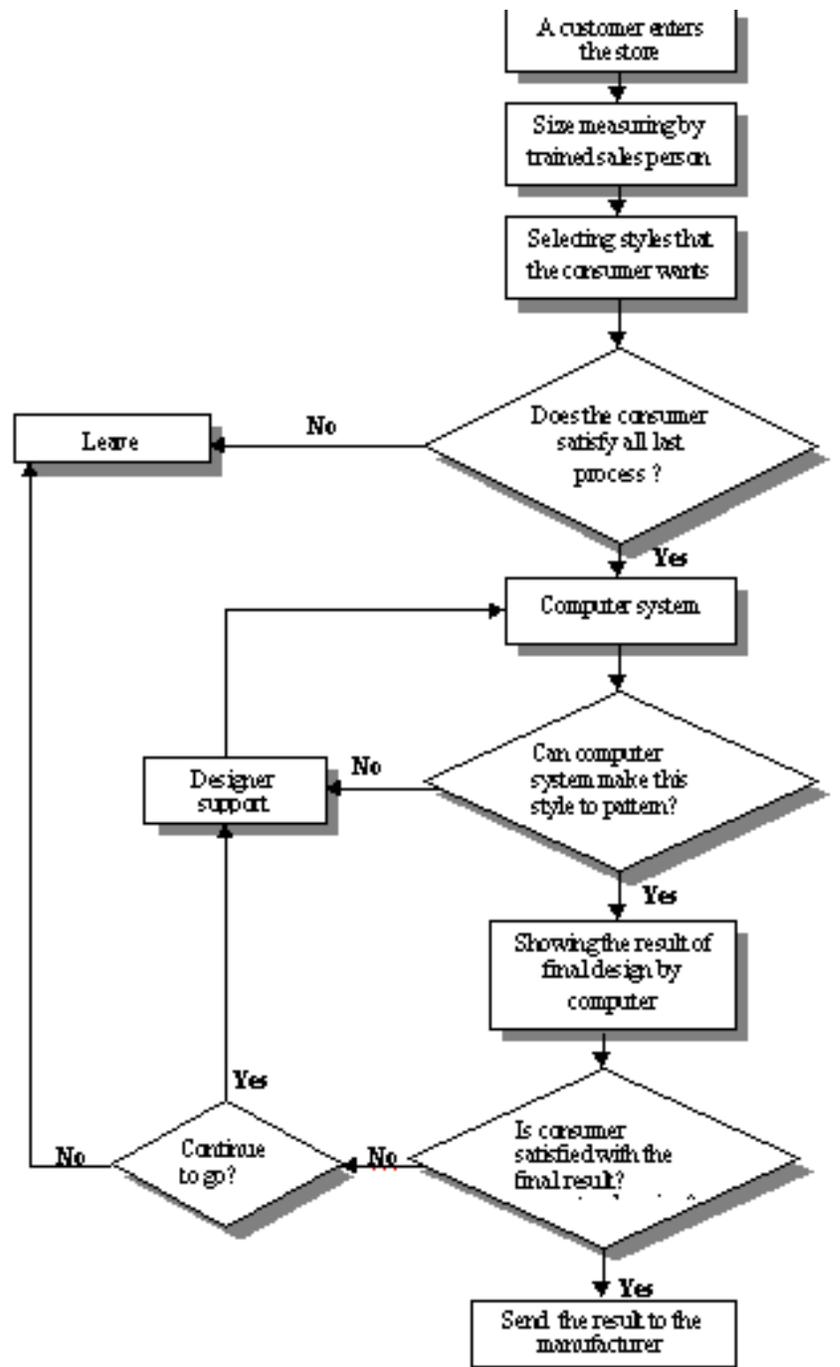
mass customization to be more ideal for both manufacturers and consumers.

In mass customization practices, the apparel industry shows similar processes of in-store activity in the following way. When customers enter the store, with the help of trained salespeople, their sizes are taken by body scanning or by hand, and the styles and fabrics they prefer are selected by sample swatches and displays. After that, information about customers is entered and stored in the computer system by trained sales people. With the computer system, every byte of information about the consumers is worked into the style pattern after being sent by modem. In case studies, it is evident that trained salespeople play an important role in apparel industrial mass customization practices. In every process, trained salespeople help the customer to choose what styles s/he desires as specifically as possible. Another similar point of mass customization in the apparel industry is that size and style selections are limited to reduce the overhead costs.

In Figure 6, in-store activities are extended based on case studies and a literature review. Every step of the mass customization process will be continued depending on the consumer's satisfaction. Specific styles and sizes are limited under mass customization processes. Based on the variety in possible choices, customer satisfaction becomes a subjective affair. Also, depending on how well the computer system adjusts style and size information to specific patterns, this process may need designer support. Ultimate success will be based on how satisfied consumers are during the early, pre-manufacturing steps of the process. So long as the consumer is satisfied to the point of commitment, the information and pattern will be sent to the manufacturer.

Only a few studies address how manufacturing processes in the factory actually produce the product that the customer orders. According to Pine's study (1997) of automobile industries, mass customization practices in the future in the apparel industry will require both automated, advanced

Figure 6. The Proposed Structure of In-store Service



manufacturing systems and flexible, dynamic organizational structures. One of the case studies (Second Skin Swimwear) may suggest that, for mass customization, the apparel industry might need special assembly design rather than work-in-process. By extending the results of the literature

review, Fig. 7 suggests the effect of the mass customization process on the apparel factory. The authors believe that this approach will ensure the customization process could be systemically implemented in the apparel industries. Further study in this area will be also shared in the future.

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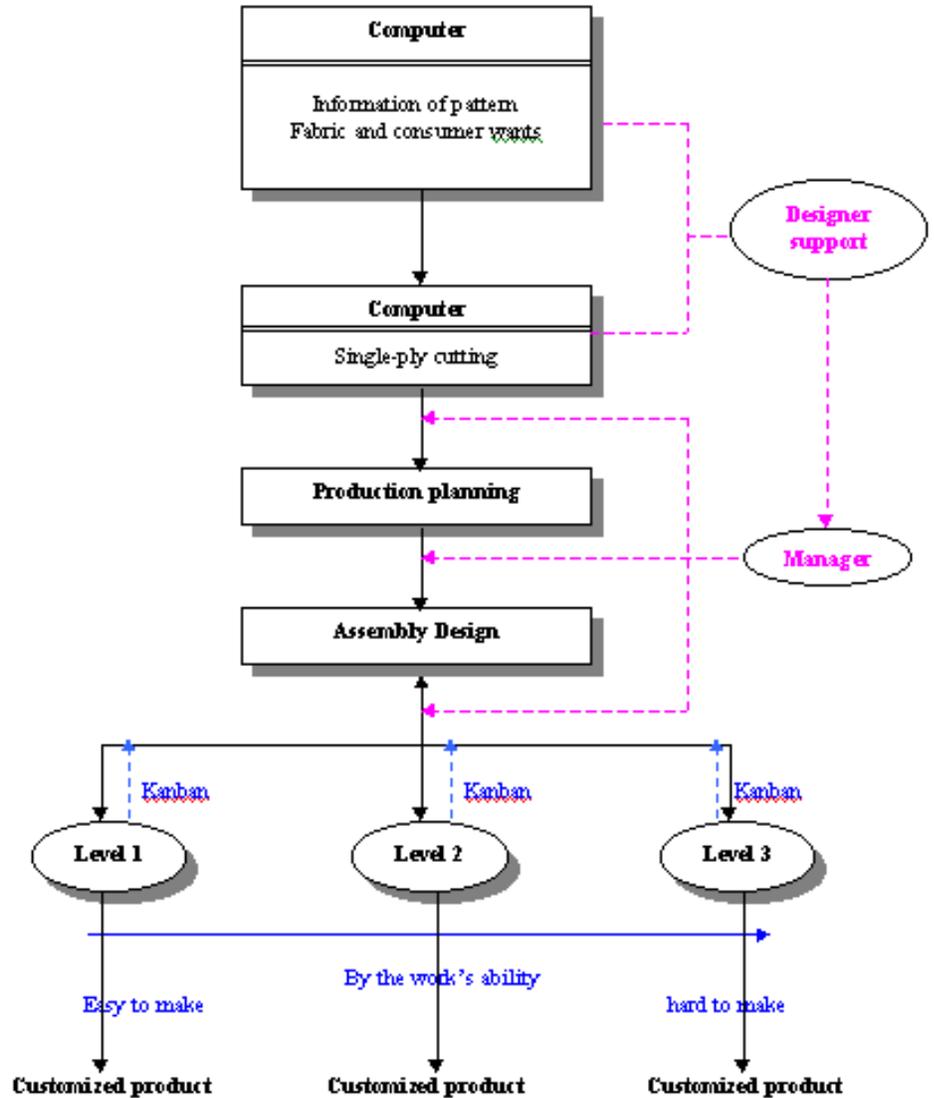
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**Figure 7. The proposed mass customization process on the apparel factory**



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