Cases of Extreme Customization and Personalization
-Current Trends of Textiles and Apparel Industry in the United States-

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미국 의류산업의 현 동향
-첨단 맞춤화와 개별화의 사례들을 중심으로-

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(2007. 8. 31. 접수)

Abstract

Environmental changes, including intensive international competition, unpredictable consumer demand, and market trends of variety and short product life cycles, have compelled the U. S. textiles and apparel industry to focus increasingly on the consumer as a way to meet these challenges. The industry began expanding into mass customization that used information technology, flexible processes, and organizational structures to deliver a wide range of products and services that met specific needs of individual customers but on a mass scale. This paper presents cases of leading-edge technology application on customization and breakthrough concepts in personalization, with a view to raising the level of debate on these issues to its highest level.

Key words: Customization, Personalization, Innovative technology, Textiles and apparel industry, Virtual reality; 맞춤 주문 제작, 개별화, 혁신적 기술, 의류산업, 가상 현실화

I. Introduction

A closer study of the changes taking place and the trends that exist in consumer behavior reinforce the need for manufacturers and retailers to rethink their business strategies. These strategies should include the way supply chains are managed and products are manufactured. Today industry is confronted by a new set of requirements. Fralix(2001) argued that the days of long runs of like products were gone - they were rapidly being replaced by the next generation of manufacturing principles. It is being called the era of "mass customization".

Fralix(2001) pointed out three key indicators in the United States that it was past time for change. The first was high service expectations. He argued that "consumers used to tolerate substandard service, but today, they do not have time for it. People are no longer willing to stand in lines and be ignored by bank tellers, hotel receptionists or other service providers. They want immediate and personalized service".

Second, consumers desire to have more variety of products. To buy shampoo, for example, a consumer has to make multiple decisions about his or her individual preferences before selecting the appropriate

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brand. They need to ask themselves about whether they have oily, dry, or normal hair; whether it is permed, dyed, or tinted; whether it is thick, thin, or gone; whether they like strawberry, apple, or kiwi fragrance. The same is true with other consumer goods(i.e., clothing). A person does not want to wear the same outfit that the other person is wearing if he or she doesn't represent a particular team.

The third reason is that consumers no longer want to order goods and services and have to wait for their delivery. Ten years ago if a catalog order was placed, the expected delivery was four to six weeks. Today, after two or three days, consumers begin to wonder where and why their merchandise is being delayed. These signals impact not only the textiles and apparel industry but also other industries such as the automotive industry, telecommunications, and bank industry. Everywhere one looks, there is a shift towards more personalized products and services.

The Internet has become a powerful tool for information gathering and communication affecting a fast growing population of online shoppers and markets. While the online market promotes significant sales for many types of products such as books and CDs, the growth of e-commerce sites in fashion industry still has been slow. In creating an unique experience for consumers and in response to consumer demand for personalized products, product designers and developers are increasingly offering products customized to meet the individual consumer's needs. This paper presents a few cases of leading-edge technology application on customization and breakthrough concepts in personalization, with a view to raising the level of debate on these issues to its highest level.

II. Literature Review

1. Body Scanning Technology and Fit

Body scanning technology contributes to the success of mass customization by allowing accurate body measurements to be taken from individuals (Fiore et al., 2001). Body scanners were designed for the purpose of measuring body shape and size(Sta-

Note. Cameras and laser lights are contained in four columns like the one seen in the right rear of the image.

Fig. 1. Scanning booth showing a person in a standing position wearing a Lycra® body suit.

ples et al., 1994; "3-D body scanning", 1994), but they have potential for other uses in the design of apparel(Lee et al., 2006). A 3D scanner captures XYZ coordinate data from the surface of an object using a series of cameras that capture information from every side of the object simultaneously(Fig. 1). These data can then be used to generate an accurate 3D image of the object on a computer screen. This image can be analyzed and measured using many techniques. The process of capturing data takes only 12 seconds so multiple scans can be captured easily and quickly(Ashdown et al., 2004; Lee et al., 2006). Information on personal body measurements from 3D body scans can be easily stored on smart cards for use in co-design and mass customization(Lee et al., 2002; Ulrich et al., 2003).

Guerlain and Durand(2006) have created data banks from body scans which are more precise and repeatable than those taken by a tailor. The E-TAILOR project is currently refining body scanning and other technologies associated with mass customization so that body scanners can be used to generate measurements portable and usable in standard formats; making the benefits of the technologies more accessible to consumers(Kartsounis et al., 2007). Body

scanning technology is also an integral part of the success of computer-aided design(CAD) systems in which traditional slopers are manipulated to fit the specific dimensions of individual consumers. The detailed measurements provided by the 3D scanners enable manufacturers to provide consumers with better fitting clothing relative to traditional methods of pattern grading when used in conjunction with CAD applications.

2. The Demand for Personalized Services and Products

Mass customization is essentially intended to meet consumers' individualized needs by using technology to aid in the modification of a standard product line in a cost effective way(Choy & Loker, 2004; Lee & Chen, 1999; Lee et al., 2002). Fit problems are also remedied by mass customization strategies which use technologies that enable the creation of tailor-fit clothing. Mass customization allows consumers to be involved, at different levels, in the design of goods, while keeping costs below that of customized or tailored goods. The interactive nature of mass customization engages the consumer in the design process.

While levels of customization may vary, consumers are able to, independently or working with a sales associate, choose an individualized combination of product style, fabric, color, and size from a set of pre-determined options, or to create a product based on his or her specific preferences(Lee et al., 2002). Co-design, a consumer-producer collaborative design endeavor, is a term used in association with mass customization. Part of the appeal of co-design for consumers is a carefully selected, but limited number of choices offered by a firm. Therefore, the consumer is allowed a manageable number of choices for mass customized goods to keep the experience of co-design enjoyable instead of overwhelming for the consumer(Choy & Loker, 2004).

3. Implementation of Mass Customization

Mass customization has diverse means of imple-

mentation enabled by supporting technologies. Lee, et al.(2002) has identified concepts related to mass customization with implications for merchandisers: product, process, and place. Products for mass customization include those "apparel types and garment features that consumers might want to customize". Process includes "customer preferences for interaction with humans and technology for mass customization". Processes used in mass customization include body scanning for personal size and fit and co-design for an individualized combination of design options and creating the customer's own unique design. Place refers to "locations where consumers might be willing to participate in mass customization". They argued that successful implementation of mass customization strategies relied heavily on the retailer's ability to respond to the consumers' need for harmony among the three concepts of process, product, and place.

In addition, strategies driving mass customization depend heavily on the effectiveness of supporting technologies. Technologies often included in mass customization are: body scanning, computer-aided design(CAD), single-ply cutters, digital printing and modular production(Burns & Bryant, 2002). The technologies are also effectively used to accurately represent products to consumers, reducing costs related to returns(Guerlain & Durand, 2006).

4. Internet Shopping and the Virtual Try-on Experience

Benefits of using body scanning technology, other than obtaining easier and more accurate body measurements and use in mass customization and co-design, include obtaining measurement information that enables computer programs with "3D visualization tools" that produce, for the consumer, a visual representation of styles and sizes of clothing on images representative of their personal dimensions (Loker et al., 2004). Virtual try-on was rated highest in its appeal by consumers asked to rank interest in applications of body scan technology. This application was also selected by respondents as "most likely to influence participants to buy more clothing on the

Internet"(Loker et al., 2004). Other applications ranked in their study includes custom fit of apparel products, size prediction and personal shopper programs, respectively.

Research has gone into the study of the effects of telepresence on on-line shopping. Telepresence enhances one's online shopping to emulate the brick-and-mortar experience, digitally, using technology which not only allows for impressive presentation of goods, but for interaction as the consumer manipulates view and style possibilities(Fiore et al., 2005). Avatars, the digital model of a person, can enhance telepresence by giving one an accurate representation of how clothing looks on the body(Gurzki et al., 2001). Avatars can be representative of general apparel sizes, or personalized to the measurements of individual consumers. Measurements from body scans enable the creation of personalized avatars.

Virtual try-on is used to allow online consumers the possibility to see themselves or a model matching their body measurements and shape(a configurable generic model) wearing simulated garments. This form of digital try-on or modeling assists in the many challenges faced by online merchants of accurately representing products(Kartsounis et al., 2007). The results of the enhanced consumer interaction with virtually modeled apparel products enable consumers to make better informed purchase decisions(Fiore et al., 2005). Data sets of accurate measurements enable procedures of digital try-on models to create avatars appropriate for consumer use through accurate representation, clear images with quick loading times.

III. Research Applications: Selected Case Studies

Many department stores and catalogs offer charts that give the measurements of the company's sizes, and that's a start. But Lands' End and other companies, such as Speedo, go even further to help consumers find the perfect fit("What's new?", 2006). At their websites, customers can even select their hair color because of creating a likeness of themselves so detailed(For a list of retailers offering this service, visit www.myvirtualmodel.com). With a few clicks

of the mouse, they can pick out the clothing they've been eyeing and see how it look on them or the virtual them.

1. Application of My Virtual Model: Virtual Fit of Apparel on the Internet

To make the online shopping experience easier and more fun for the consumer, some retailers are incorporating visualization technology such as that offered by My Virtual Model, Inc. The user can input measurements and create an avatar to visualize clothing on the body similar to their own, and to find size selection information about specific clothing styles. <Fig. 2> shows the procedure to create a consumer's own avatar.

My Virtual Model Inc. has set the standard for online apparel shopping. Two core technologies-My Virtual Model^{TM}, Dressing Room and My Fit-enable consumers to "try on" clothes on the Internet. For merchants, deploying My Virtual Model technology improves bottom-line profitability by increasing revenues while cutting costs. Shoppers using My Virtual Model solutions spend more, buy more and return far fewer items-resulting directly in reduced shipping and handling costs("What's new?", 2006).

The model a customer creates will be his or her personalized model that only he or she can use to view simulation online with retailers and websites offering My Virtual Fit Model. Following companies offer virtual-try on experience on customers' own avatars and custom-made clothing for them: Sears (outerwear and activewear), Lands' End(outerwear, activewear, swimwear), H&M(swimwear, women's jeans), speedo(swimwear), Adidas(active wear and swimwear)(visit http://www.mvm.com/en/go_shopping. htm).

Recently, virtual model is also used as weight loss simulator by Levi Strauss Signature® and Prevention.com. Like <Fig. 3> shows, a consumer can see how the jeans look on her now and when she reaches her personal goal weight. Levi Strauss Signature® jeans and Slim Fast® help customers achieve their perfect fit.
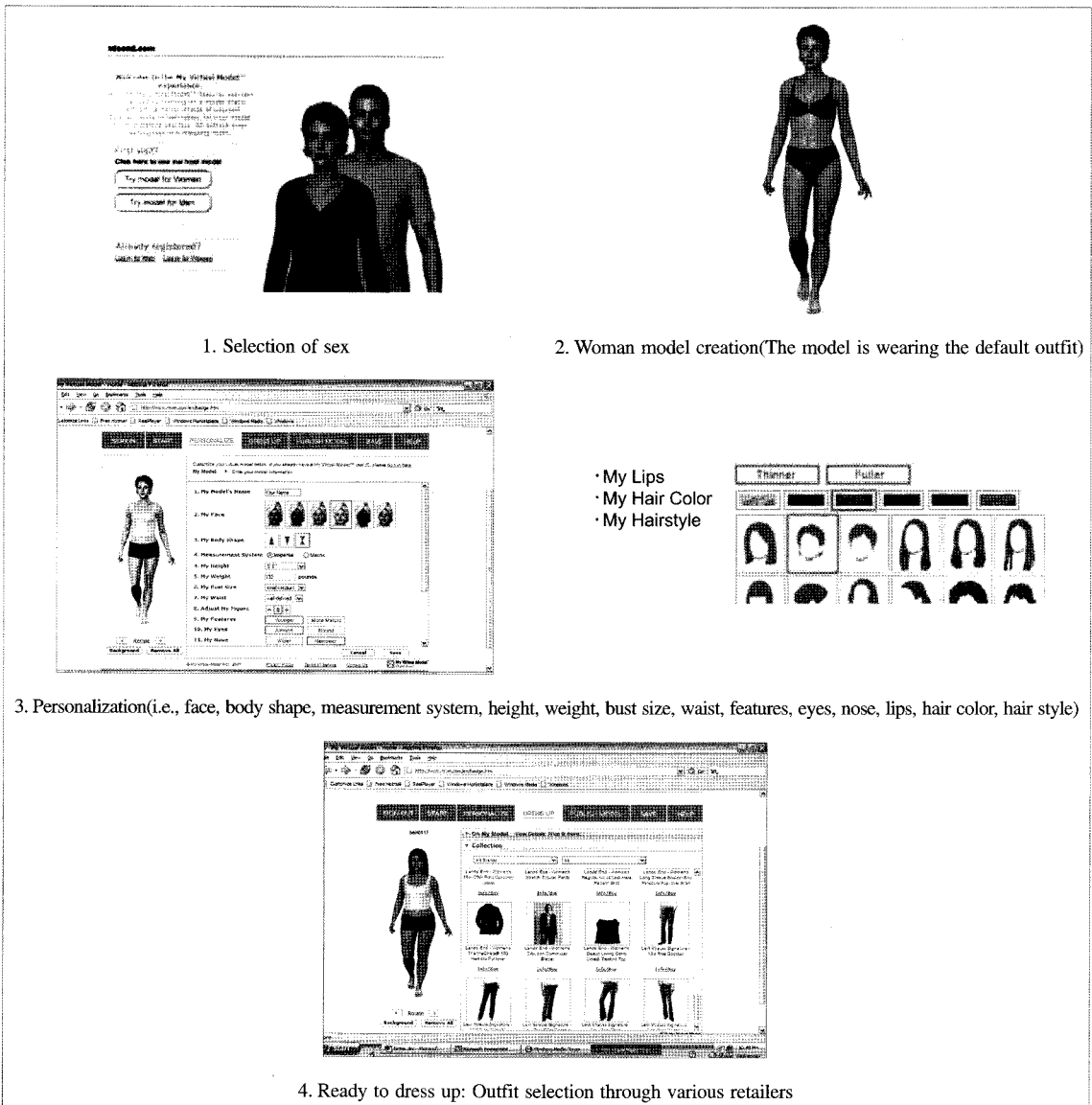
1. Selection of sex   2. Woman model creation(The model is wearing the default outfit)

· My Lips
· My Hair Color
· My Hairstyle

3. Personalization(i.e., face, body shape, measurement system, height, weight, bust size, waist, features, eyes, nose, lips, hair color, hair style)

4. Ready to dress up: Outfit selection through various retailers

Fig. 2. Procedure of creating My Virtual Fit Model.

2. Selected Company Application of Mass Customization

Many companies, including Levi Strauss, Second Skin Swimwear, Brooks Brothers, Custom Foot, Nike, Target Corporation, and Beyond Fleece(http://www. beyondclothing.com/) are operating at various levels of mass customization. Levi Strauss & Co. was the first large apparel company to offer mass customiza-tion through jeans, offering choices in style, fabric, finish, color, and inseam length. Jeans fit is deter-mined by inputting the individual's measurements, acquired manually by a salesperson, and preferences into a computer program then having the customer try on sample jeans(visit http://www.levistrauss.com/). Brooks Brothers also offers a mass customization system at their New York City retail store, integrated with new technologies including a 3D body scanner
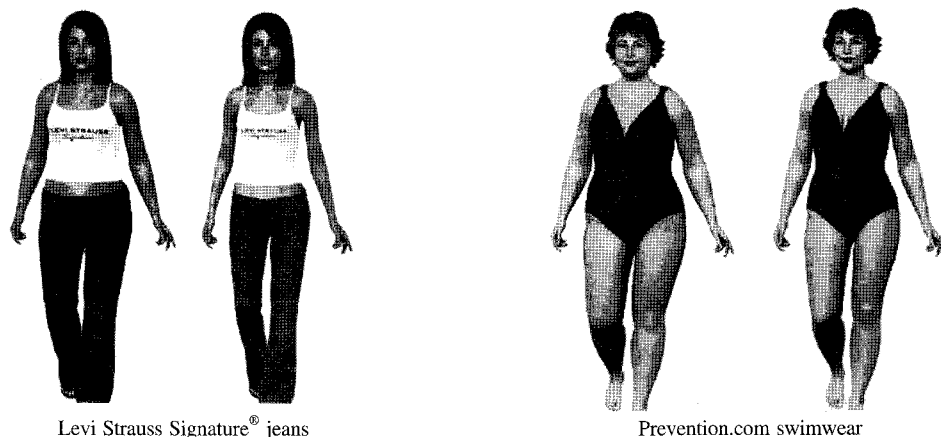
Levi Strauss Signature® jeans   Prevention.com swimwear

Fig. 3. Virtual model used as weight loss simulator.

to collect customer measurements.

Lands' End Inc. first offered customers the ability to customize apparel through the website in 1999 (Ives, 2003), then expanded the service from men's chinos to men's and women's jeans, men's shirts and jackets, and women's chinos, blouses, and outerwear. <Fig. 4> shows the process of creating custom-made clothing(i.e., chinos), including fabric and color, style, and fit customization. The custom-made clothing process of Lands' End is similar with that of other companies that produce custom-made clothing.

There are a few examples of other manufactures involved in mass customization emerging in the electronic marketplace. Customers can participate in the design process for men's or women's shirts using "VirtualTailor" which is a virtual company with no physical store(visit http://www.shirttailor.com/). The software allows consumers to drag and drop features such as collars or cuffs onto a shirt to see how the product they designed will look before they place an order.

However, apparel companies that have experimented with mass customization have not all been successful in satisfying their consumers and making a profit. For example, the Custom Foot Corp., a company that provided customized footwear to consumers on the East Coast, went bankrupt in 1998 due to customer dissatisfaction with its customized products. When Levi Strauss experimented with offering custom-fit jeans through retail stores in 1994, the

original Spin program at Levi Strauss & Co., San Francisco, a custom-made jeans business, was not financially self-sustaining.

## 3. Technological Advancements for Mass Customization and Personalization

Do you know those airport scanning machines? Imagine walking into one and having low-grade radio waves take your precise measurements. That is what Intellifit devices are doing at certain Levi's stores right now. A customer walk fully clothed into a cylindrical booth and 200,000 points of data are taken and sent to a computer that creates a printout of his or her dimensions, along with a list of the sizes that will work best within a given brand. Participants also receive an ID card that can be used to log on to the Intellifit website(http://www.intellifit.com/Intellifit/Home.aspx) to get size recommendations and place orders. Brands like Polo, Nordstrom, Nautica, Levis, Lands' End, Dockers, and Gap are available online. The greatest benefit, however, might be that the retailers can used the collected information to create clothing geared to the body types of the people who most regularly shop with them.

The Intellifit FitPrint™, contains over 200 body measurements and compares them to current brand name clothing dimensions for a guaranteed fit. A customer's Intellifit FitPrint contains all the informa-

Initial Stage: Decide the product type from jeans, chinos, or blouses
(Also offers for men, children, and swimwear)

Example: Woman's Chinos

Step 1 Fabric & Features: Choose color, fit, waist style, front style, belt loop, front pocket style, hem/cuff, leg, back pocket style
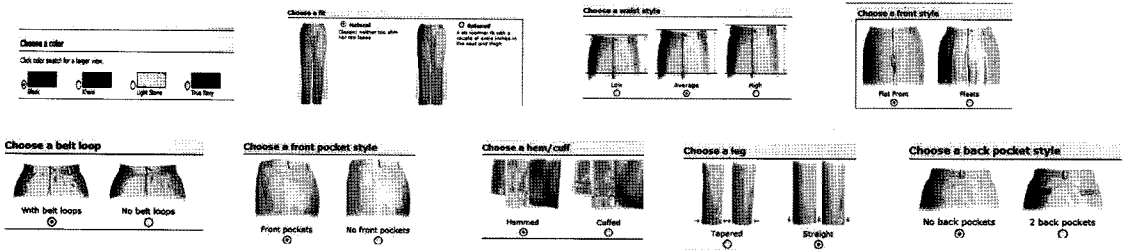
Step 2 Design Your Fit: Answer about your measurements and proportions.
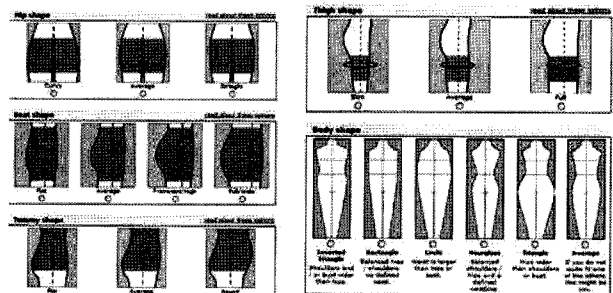
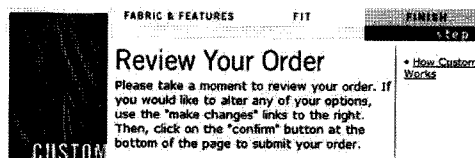**Step 3 Review your order and place**

Fig. 4. Lands' End: Basic process of creating custom-made clothing.

tion needed to match him or her to the clothes that will fit him or her the best. The FitPrint includes thigh, front and back rise, low hip, high/mid/low waist, neck, chest, sleeve measurements and other fit data - basically, the same measurements a high-end tailor would use to make custom clothes. Within minutes of stepping out of the Intellifit device, the customer is ready to shop via intellifit.com, where he or she can match his or her FitPrint to current brand name apparel.

Intellifit helps customers quickly find clothes that fit while it also helps clothing brands and manufacturers create clothes that fit more people. Finding what fits saves time and money for consumers, their favorite stores, and their favorite online clothing source because they know the fit is right before they even take the time to try on the clothes. The steps for using this equipment are available at the Intellifit website and also listed as follows: (1) Walk into a see-through Intellifit booth; (2) in 10 seconds, Intellifit uses a totally safe radio wave to collect numerous, accurate measurements of your body - while a person

remains fully clothed; (3) receive a confidential computer printout listing those brands and sizes that fit you best; and (4) once the person used Intellifit, he or she can quickly find what fits in the mall, the department store, and online. You will soon be able to visit intellifit.com and search by category(jeans, swimsuits, dresses, suits, sportswear, dress shirts, lingerie, etc.) to find the brands and sizes that fit you best.

Intellifit compiles the anonymous, aggregated data about all the bodies measured to help clothing manufacturers and retailers improve their fit and their operations so that they can create and stock clothes to fit real people("What's new?", 2006). In short, Intellifit provides a benefit for everyone who wears, buys, makes, or sells clothes. Intellifit is currently building a network of mall, airport, and department store Intellifit kiosks. National and private label clothing brands sponsor these installations to increase customer satisfaction and brand loyalty. Retailers are installing Intellifit systems independently or in conjunction with shopping malls.

Similar to Intellifit, [TC]^2 device scans bodies using light instead of radio waves to gauge measurements(visit http://www.tc2.com/index.html). [TC]^2 has scanned 10,000 volunteers for the SizeUSA project, a size study of more than 6,000 women co-sponsored by 31 retailers and brands. The project's aim was to help merchandisers improve overall fit. Although the technology is new, some of the companies have already applied the findings. For instance, in 2005 Jockey launched a new line of bras based on Size-USA data. JCPenney used the data to make its size 8's more uniform and is now working on doing the same for all its other sizes("What's new?", 2006).

Fit Technologies, a Dallas-based sizing company, has introduced a shape-based system called Fitlogic (visit http://www.fitlogic.net/). Each garment is sized in typical fashion, from 0 to 18. Clothing is then manufactured for three body types - straight, designated 1; hourglass, 2; and pear-shaped, 3(Fig. 5). So, if you are a size 6 with a pear shape, you would buy a 6.3. Some major department stores(i.e., Macy's, Nordstrom and QVC) tested the formula in 2006.

Even more ambitious is the offering at www.myshape. com. Built as an online mix of department store and
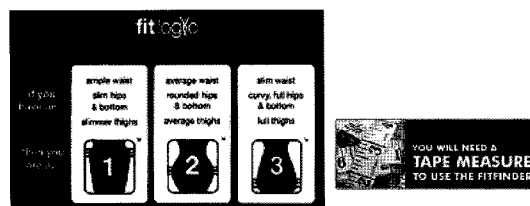

Fig. 5. Fitlogic: Shape-based system.

fit-concierge service, the site asks customers to enter detailed measurements and style and fit preferences. A mathematical formula is then applied to assign the customer to one of seven body types the company has identified(i.e., shapes M, Y, S, H, A, P, E).

## 4. Newly Evolving Virtual Worlds: Extreme Makeover of Retail

Virtual reality technology allows users to assess conceptual designs, analyze products before they are manufactured, check functionality and aesthetics, and modify designs without physical prototypes.

Second Life(SL) is a simulated world with more than 700,000 residents, or players, who sometimes refer to their offline existence as their "first life". San Francisco-based Linden Lab, the company behind the SL, has provided a platform for players to do whatever they want, whether it is building a business, or launching a space shuttle. Residents chat, shop, build homes, travel and hold down jobs, and they are encouraged to create items in SL that they can sell to others or use themselves(visit http://secondlife.com/whatis/). Second Life for korea has recently opened (visit http://kr.secondlife.com/).

Many virtual items are bought and sold in SL and clothing has emerged as one of the hottest categories. Real clothing makers, including American Apparel Inc. and Adidas, sell items in the SL that mimic apparel they sell in the real world. Thus, players can dress their avatars in some of the same clothes they wear themselves in their real world.
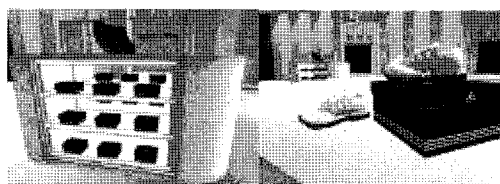
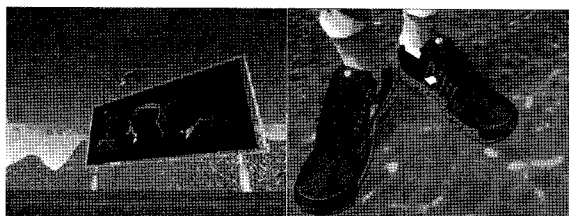### 1) American Apparel's Virtual Clothes
American Apparel, a fashion brand known for its ability to make cotton shorts and leotards hip and sexy, entered a new realm. The retailer, which had 80
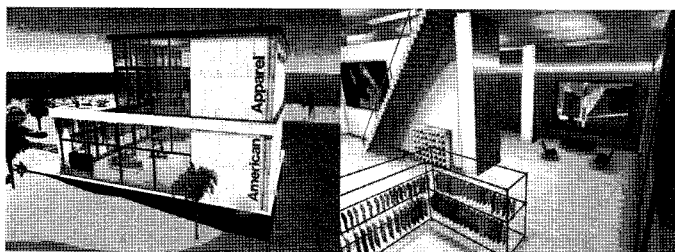
Opened on June 2006   Closed on summer 2007

Fig. 6. American Apparel in Second Life - Lerappa Island.

Fig. 7. Adidas in Second Life.

locations nationwide, was adding one more(Girard, 2006). In June 2006, it opened a store on a private island in the virtual world of Second Life(SL) called Lerappa Island(Fig. 6).

American Apparel was the first major retailer to set up shop in the SL. Official American Apparel merchandise sold in the virtual world and the store boasts familiar items available for shoppers' online character, called an avatar. It is conceivable that the company could also offer new clothing exclusively in the SL, or even use the virtual world as a place to test new clothing lines. Virtual customers can see a model of an item in 3D and can see the front, back, and sides of an item, which they cannot easily do on a normal website. Within the virtual outlet, browsers can purchase the real-world version of an item through the company's website and have it delivered. The virtual store - Lerappa Island was closed on summer 2007 because of lacking customer visits.

2) Adidas Reebock

Adidas has opened a store on a private island in Second Life(SL) on September 2006 to promote and receive feedback on its latest shoes. It is fairly similar to the American Apparel(AA)'s outlet, although

unlike AA, Adidas's store was focused on a campaign for a single product(a3 "bouncy" Microride shoe) and the shoes' positioning was demonstrated not only visually but also interactively(Fig. 7).

Besides the store itself, the Adidas complex includes a dome that projects a branded video clip, a few billboard installations, and an orange "testing area" trampoline to demonstrate the shoes' "bouncy" positioning. The shoes themselves contain a script that makes avatars jump to the sky. Unlike the American Apparel store, Adidas sells only one product - the a3 that comes either in white or red and black styles. So the virtual world is used as a sandbox to measure new product interest and further push the envelope on create sweet new kicks.

IV. Conclusions and Recommendations For The Future

Today's consumer wants more variety and more direct input into the options that are available. They want retailers to cater to them. Mass customization has become an industrial household name and can now be found in almost every article written on the research topics of innovation, technology manage-

ment, product development, or supply chain management. Nowadays, whatever manufacturers or retailers offer, they have to tailor products each and every time, with the needs of the individual buyer or user in mind.

Personalized advertising is transforming marketing, advertising, and media business. Virtual identity, product placement in games and movies, televisions and ads, social shopping and communities are driving and transforming forces in the market. How merchants, brands and retailers will address this new wave of interaction is the key to succeed in current, competitive textiles and apparel industry.

Virtual reality as a pre-production tool is an emerging reality in the fashion world. This type of total software system(i.e., Optitex TM system) integrates garment design, surface design, fit, construction and 3D virtual presentation - before a real prototype is made. This 3D virtual reality project in Second Life and Virtual Fashion applications will also help educators prepare students for the impending changeover into the 3D integrated pre-production package that is currently emerging in the industry.

In 2006, the i-Fashion Technology Center, based in Seoul, Korea, was found to conduct governmental projects for the next 5 years collaboratively with academia and several hi-tech companies domestically and abroad. This coalition was created to form industry paradigm that was both service and consumer oriented. Chang-Kyu Park, the center director commented "Existing shopping trends will become more complex and efficient; that is to say, anyone will be able to shop anywhere through multiple distribution channels such as online, through mobile services, and television based on the ubiquitous nature of evolving services. Besides actual clothing, virtual clothing will also add value. In the future some clothing will be digitally popularized with enhanced high-quality services and customization in addition to the more traditional values such as brand, design, and material"(Davis, 2007). The i-fashion project is the unique start in Korea's textiles and apparel industry; however, continuous attention and effort should be given to this innovative product development field.

Mass customization employs technology to pro-

vide for the consumer apparel with personalized fit at less expense than tailored clothes. Mass customization can also allow consumers to choose style as well as fit options; however, mass customization has never been envisioned as replacing mass production. Rather, the two will coexist and evolve as opportunities for consumers, manufacturers, and retailers.

In future markets, the growth potential for customized and personalized products is increasing. The use of innovative technologies such as 3D body scanning technology, digital printing technology, virtual try-on application, and electronic integration, is expected to bring high added value to product application in apparel, medical, automotive, and other markets. To strengthen competitiveness in the global textiles and apparel industry, new product development coupling with these innovative technologies has become a key business strategy.

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요　약

과도한 국제경쟁, 예측하기 어려운 소비자들의 소비동향, 상품의 다양성과 상품의 사용 기간 단축을 포함한 환경의 변화들은 미국 의류산업에 혁신적 변화를 촉구해 왔다. 미국 의류업계는 이러한 도전들을 극복하기 위한 방편으로 소비자 중심의 사업 체계로 전환해 왔다. 의류업계는 저가격 중심의 대량생산이 아닌 정보기술, 유동성 있는 생산과정, 의류업계의 혁신적 조직구성을 접목한 맞춤형 주문제작 형태를 늘여가기 시작하였다. 이는 소비자들 각각의 필요를 충족시키기 위해 상품과 서비스의 범위를 넓히기 위한 수단인 것이다. 이글은 현 미국 의류산업의 동향을 살펴보고 몇몇 혁신적 의류사업체들이 어떤 형태로 소비자들을 만나고 있는가를 제시한다. 이는 극도의 정보산업과 혁신적 기술산업의 접목을 추구하는 미국 의류산업의 현황을 잘 보여주며 미국 의류업계들이 과도한 국제경쟁 사회 속에서 이익추구를 위한 탈출구를 어떻게 마련하고 있는 지를 보여주는 좋은 예가 된다. 더 나아가 이는 한국 의류업계가 혁신적 전환을 시도할 시 좋은 예들로 사용되어 질 수 있을 것이다.