Development of a system for sustainable fashion from recycled clothes
- Based on U.S. fashion brands -

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Abstract

Fast fashion companies have generated enormous amounts of clothing and large quantities of unsold or short-lived clothing end up in the landfill. As if to counter fast fashion, sustainable fashion has arisen for environmentally friendly garments at different levels from the fiber stage to production stage. However it is still fraught with uncertainty of systems in the industry. Therefore, this study proposed a system to create re-valued clothing from recycled garments for retailers. The target companies are large-sized retailers like Levi's, Polo, Gap, or J-Crew which are consistently producing basic items such as Levi's 501 or Classic Polo shirts with middle-prices. At the material stage, this study recommended additional requirements of designing a garment with a long life cycle based on criteria of an ideal garment developed by Patagonia clothing company. Then, this study explored innovative ways that retailers might connect with consumers to allow direct interaction between them in terms of the process of collecting used clothes. Using recycled clothing as a source material, this study strove to offer a process of redesign where the concept of 'waste to fashion' is developed as reconstructions where old forms are transformed into new ones.

Keywords: sustainable fashion, recycled clothing, U.S. brands

I. Introduction

The method of producing enormous amounts of low cost fashion forward clothes, orchastrated from around the global has rapidly developed into a blueprint for trade, logistics and marketing. Fast fashion has a very short development cycle. Fashion companies have become adept at updating their products so that stores and websites offer constant rejuvenation. Possibly the most contentious and problematic fallout of fashion

has been the assertion that production of fast fashion heightens environmental and contamination issues. Questions of how reckless production behavior might be curtailed and how consumer acquisition might be amended are tackled here. As if to counter fast fashion sustainable fashion has arisen.

Fashion industry has several approaches to sustainable fashion. The first strategy is made with the changes at the level of raw materials. Sustainable fashion using organic fibers has been conducted as a system and they succeeded in yielding a profit and mini-

mizing potentially negative impacts on nature simul-taneously. Major fashion companies such as Nike and Mark & Spencer primarily have chosen a strategy of producing eco-friendly products by integrating organic cotton into their product offering (Environmental Protection, 2011; Sullivan, 2007).

The next approach of sustainable fashion industry is "recycling post-consumer textiles" (Hawley, 2006). Collected clothes are used mainly in four ways: export to developing countries, break down recycled fabric to fiber through chemical or mechanical pro-cessing and convert to new products, resell via vintage shops, or reconstruct at the level of haute couture (Claudio, 2007). However, this strategy is still fraught with the problems such as uncertainty of development. In order to develop a system for common practice and transform post-consumer clothes to fashion within the boundary of profitable market, it has some issues needed to be solved. The main first issue is that collecting and sorting process is not systematic, and the second issue is that the aesthetic smartness and newness of the brand is pitted against vintage and reconstructed clothes with their inflection of fashion and possibility.

Therefore, the current study proposes a way that retailers directly collect their old clothes which they sold to customers before, while current recycling industries purchase recycled clothes collected by charities or counties. Then, this study develops a sustainable apparel design method that fits the McDonough triangular model (McDonough & Braungart, 2002) of "Equity, Economy and Ecology" by using recycled clothing as a viable renewable raw resource with no loss of quality in terms of fit and style. If there is a way to connect retailers to consumers, it will allow direct interaction between both parties and stimulate the process of collecting used clothes. Then using recycled clothing becomes a resource material capable of altering the fashion industry. If this policy could be used in practice, customers might reconsider their clothes and the way clothes are discarded, notions of

fashionability and what constitutes freshness of ideas.

II. Literature Review

1. Environmental impact of fast fashion

Fast fashion fulfills consumer desire for the seasonal "must-have" that has become an eternal lure for customers. Fast fashion has generated new levels of demand for skills, services, transportation, design, materials, fabrics and most importantly waste.

Demand of man-made fiber, especially polyester has nearly doubled in the last 15 years, and continue to increase (Textile Intelligence, 2010). It is an energy intensive process requiring large amounts of crude oil and releasing toxic emissions including acid gas. Volatile monomers, solvents, and other by-product of polyester production are emitted to water, air, and soil. Although cotton has been considered as preferable fibers for environment, cotton grown by conventional way has significant negative impacts on environment. According to Textiles Intelligence report (2010), the share of natural fibers in total fiber output is 41.4%, and cotton is used most widely. It was found that 10% of all agricultural chemicals in the U.S. are used to produce cotton, grown on just 1% of all major agricultural land. Conventional cotton crops in California alone are dusted every year with 6.9 million pounds of chemicals. And extensive and intensive use of synthetic fertilizers, soil additives, defoliants and other substances is wreaking havoc on soil, water, air and many living creatures.

With respect to consumption behavior, an estimated 21% of annual clothing purchases stay in the home, increasing the stocks of clothing and other textiles held by consumers (Hollins, 2006). This stockpiling is considered to represent a potentially large quantity of waste that will eventually enter the solid waste stream. Americans throw away more than 68 pounds of clothing and textiles per person per year, and clothing and other textiles represent about 5% of the municipal solid waste (EPA Office of Solid Waste,

2008). Enormous amounts of clothing are produced and large quantities of unsold or short-lived clothing end up in the landfill.

2. Strategies of current sustainable fashion industry

Industry and consumers tend to be in favor of fast fashion, whilst sustainable fashion has found support in the fledgling green fashion industry and academics who tend to report on what is happening in the green fashion industry rather than develop new systems. Attempts have been made by eco-conscious individuals and organizations to raise awareness of the issue, "sustainability", provide less harmful choices and influence consumer behavior with regards to individual purchases and habits.

Sustainable fashion also referred to as "eco-fashion" or "green fashion" which is a part of the larger pronuciation of sustainable design which is where products are created with consideration of the total life span of the product and the products' impact on the planet.

In Vogue USA, Robert Sullivan (2007) explored the conscientious-clothing movement, 'Earth to Fashion', and reported that sustainable fashion appears not to be a short-term trend but one that could last multiple seasons. Although we cannot make sure whether sustainable fashion is a passing trend or not, current conscientious-clothing movement can be considered as a precursor for contributing to the future environment.

Fashion companies are trying to save natural resources by making conscious decision to use more environmentally-friendly materials and socially responsible methods in clothing production. Major fashion companies such as Nike, Wal-mart, and Mark & Spencer primarily have chosen a strategy of producing eco-friendly products by integrating organic cotton into their product offering.

This strategy is made with the changes at the level of the raw material, and after this level they use traditional mass production system that can save labor cost. Sustainable fashion using organic fibers has been conducted as a system and they succeeded in yielding a profit and minimizing potentially negative impacts on nature simultaneously. In 2011, organic fiber sales in the United States grew by 17.1% over the previous year, to reach $708 million, according to the Organic Trade Association's 2012 Organic Industry Survey. According to growth by category, women's apparel grew by 43%, infant clothing/diapers by 40%, men's clothing by 43%, and children's clothing by 52%. Also, global organic cotton product sales projected to rise to $2.4 billion by the end of 2008, reflecting a 116% average annual growth rate.

The next approach of sustainable fashion industry is "recycling post-consumer textiles". Post-consumer clothing is defined as any type of garment made from manufactured textile that the owner no longer needs and decides to discard (Hawley, 2006). Although it is important to choose eco-friendly fabrics when possible, a greater impact can be made by buying used and vintage clothing and avoiding unnecessary clothing purchases altogether (Brower & Leon, 1999). According to the United States Environmental Protection Agency, Americans discard approximately 13.1 million tons of textiles annually. Only 15% of which is collected for reuse and recycling in 2011 (United States Environmental Protection Agency, 2012). This amount of textile waste representing 10 pounds for every person in U.S. Clothes are primarily collected through charities such as the Salvation Army and Goodwill Industries. Since the U.S. government offers tax incentives for citizens who donate house hold goods to them, clothes are successfully collected by two organizations. The rest of textiles are collected through counties by regular curbside recyclable pickup. Collected clothes are used mainly in four ways: export to developing countries, break down recycled fabric to fiber through chemical or mechanical processing and convert to new products, resell via vintage shops, or reconstruct at the level of haute couture (Claudio, 2007).

〈Fig. 1〉 Gary Harvey's recycled couture

Only about 20% of clothing donated to charities is directly used or sold in their thrift shops. Then they sell unsold clothes at their thrift shops to textile recyclers at 5‐7 cents per pound. About 61% of the clothes are exported to foreign countries. Certain brands and rare collectible items are imported by Japan, the largest buyer in terms vintage or American high-end fashion.

Despite of small portion of the market, vintage shops or innovative high fashion designers are dealing with post-consumer cloth for sustainability. Post-consumer clothing used to carry the stigma of the ragged or outdated styles, however today wearing unique, well-made vintage pieces combined with the modern clothing are considered as a way of expressing their individual identities. High fashion designers modify clothing they collected or purchased and redesign them by reassigning garments to new uses. For instance, Gary Harvey has deconstructed and reconstructed known brands like Burberry and Levi's jeans in his shows (Björk, 2010) (Fig. 1).

3. Current issues in sustainable fashion design

Textile recycling industry can be considered as one of the most valuable industries for sustainability. Yet it has some issues needed to be discussed in order to develop a system for common practice and transform post-consumer clothes to fashion within the boundary of profitable market.

First of all, in terms of sorting process, since clothing are collected from people with various sizes, items, and styles, it is difficult for recyclers to sort them. Trans-America Trading Company, one of the biggest of about 3,000 textile recyclers in the U.S., separates used clothing into 300 different categories by type of item, size and fiber content (Claudio, 2007). Therefore if a system which can facilitate collecting and sorting by category can be proposed, it could save time and labor expenditures.

Secondly, recycled fashion sold at vintage stores has an obstacle because a strong aesthetic of smart-ness and newness still prevails among the people. Appadurai (1986) noted that the changing roles of objects can produce dramatic effects: 'an eventful biography of a thing becomes the story of the various singularizations of it, of classification and reclassifications in an uncertain world of categories whose importance shifts with every minor change in context. In other words, if we highly invest in conceptual transformation in order to remove or conceal the potentially polluting nature of used clothing, customers could be less discriminating in their pre-ferences.

Therefore rather than just reselling recycled clothes, individual high fashion designers such as Marin Margiela and Gary Harvey strive to use and customize them by adding aesthetic values. They have succeeded in making sustainable clothing evolve into styled fashion, whereas global companies such as Patagonia invest in development of raw material rather than design. However, in terms of clothing production high fashion designers are in the rudimentary level, due to relying on individual production system. They cannot sell with low price because of high labor cost and recycling cost. In other words, it is still trapped in to the vague of development systems for common practice. There is a lack of strategies of how we can recycle products and transform them to fashion, with in the boundary of profitable market.

However, by adding aesthetic values in the garments,

high fashion designers using post-consumer clothes force fashion elites to take active interests in sustainable fashion. According to Simmel and Levine (1972), fashion arose as a form of class differentiation in a relatively open class society. The elite class seeks to set itself apart by observable marks, such as distinctive forms of dress. Members of immediately subjacent classes adopt these insignia as means of satisfying their desire to identify with a superior status. However, fashion is set through a shift from the fields of class differentiation to the area of collective selection after 1960s (Blumer, 1968). Fashion is no more selected by elites, and instead through a continuing process of collective selection from among competing models reflecting current and recent styles. If designers manage to provide with affordable prices, and also balance the trendiness that can reflect what customers are seeking to anticipate, the post-consumer clothes can be the primary fashion trend by a wide range of customers, not just by fashion elite class.

III. Objectives & Methods

The overall objective of this study is to propose a system to make a new garment from recycled garments for retailers. The target companies are large-sized retailers like Levi's, Polo, Gap, or J-Crew which are consistently producing basic items such as Levi's 501 or Classic Polo shirts with middle-prices. Basic items do not have complicated details so that they are suitable for adaptive reuse and redesign. Although a trendy retailer, Urban Outfitters, has an "Urban renewal" line made from post-consumer clothing, it is a limited-edition line which is created by purchasing from individual designers outside the company. The current study proposed system intends to create an "unlimited-edition" line based on abundant basic styles and mass commercial production.

The first specific objective of this study is to propose a way that retailers directly collect their old

clothes which they sold to customers before, while current recycling industries purchase recycled clothes collected by charities or counties. Since charities collect recycled garments with various items and styles from people of different sizes, they have to spend time and labors for sorting and recycling by category. However if retailers decide which items they plan to reuse as a raw material for a new design and then ask customers to return them, it can aid in saving time and labor expenditures for sorting and recycling.

The last objective is to develop a sustainable apparel design method that fits the McDonough triangular model of "Equity, Economy and Ecology" by using recycled clothing as a viable renewable raw resource with no loss of quality in terms of fit and style. This study focused on not only creating meaningful, functional, and re-valued clothing for customers, but also generating profits for retailers.

IV. Results: Proposal of a System to Create Re-valued Clothing from Recycled Clothing

1. Material selection stage

Initial design is important since it is estimated that as much as 75% of the environmental impacts as well as the costs that a product throws off throughout its lifetime is determined at the design stage (Ottman, 2008). This is the time when the materials are chosen, the manufacturing methods are designed, and the amount of energy required and how easy the product will be recycled are determined.

At the initial design level, many enormous and mainstream companies such as Nike merely commit to buy increasing amounts of organic cotton and stop using PVC vinyl. However, they might interpret it as a tool for their self-serving image building, and it is not a fundamental approach for designing sustainable garment. Therefore this is why it is valuable to look at Patagonia. Patagonia is one of the most visible

〈Table 1〉 Criteria of an 'ideal garment' (Brown & Wilmanns, 1997)

Components	Criteria
Product design	· Long product lifespan - minimum 10 years · Meet performance criteria · Easy of repair, component reuse and composting/recycling · Product requires minimum care
Materials selection	· Natural fibers produced in sustainable manner · Recycled content · All inputs to material production identified and toxicity characterized · Toxics: if used, they should be produced, consumed, and detoxified on-site/the final product should not be toxic
Production process	· Energy and water use analyzed and optimized · Efficiency of material use analyzed and optimized · Wastes are eliminated and there is no disposal from production
Distribution	· Packaging manufactured from renewable resources and finally recycled or composted · Transportation is optimized for energy efficiency · Energy from solar-based system
Product maintenance	· Consumer care is minimized · Products only requires cleaning with cold water and mild soap, then line dried/ no ironing or dry cleaning required · Quick and cost effective repair service offered
End of life	· Consumer urged to use and keep products if it is still useful · Product can be returned to Patagonia if the customer does not want to dispose of it · Where feasible, systems in place for disassembling non-compostable products for component reuse, material recycling and remanufacture

and influential companies with various approaches for a sustainable design. In order to define an 'ideal garment', they settled on modified Life Cycle Assessment (LCA) which contains six components of an ideal garment (Brown & Wilmanns, 1997) (Table 1).

Based on these six criteria, a rating system with 1 - 5 scale was developed, with 5 representing an 'ideal garment'. If the overall average score is below score 3, the product is returned for review. Product development staff examines individual components of the review to determine the significant problems. Although this process is subjective and still has weakness due to relying on qualitative assessment, Patagonia is a pioneer and contributor to apparel companies in terms of applying Life Cycle Assessment (LCA) to apparels and implementing solutions to the environmental crisis. Six criteria of Patagonia presented ways of designing a garment with a long life cycle.

However, the current study intended to redesign

〈Table 2〉 Requirements which need to be included in 'product design criteria' of Patagonia for designing a new garment from recycled clothes

Components	Criteria
Product design	· Design timeless classic styles with few complicated details rather than conforming fashion trend, so that they are conducive for adaptive reuse and redesign · Reduce number of patterns and assembly operations in order to be easily converted into new products
Materials selection	· Use fibers with high tear resistance · Make label material easily recyclable

and reproduce lines of reconstructed garments using recycled clothing with a long life span. Therefore extra requirements need to be added to criteria developed by Patagonia, so the researchers in the current study proposed to add the following requirements to produce a sustainable fashion(Table 2).

Few companies have succeeded in making 'classic' lines so far, while most companies follow fashion trends to earn profit immediately. In current market, Levi's 501® Original jeans (Levi's), Classic boot cut jeans (Gap), or Classic Polo shirts (Ralph Lauren) are considered as examples of classic styles with middle-prices. These basic styles can be defined as 'Classics' since they have been worn for many years. They fulfill requirements for the current study. They are marked as best-selling items and keep selling everyday, so they were chosen as raw materials since it is convenient to collect a large quantity of these items from customers, and reconstruct under a set system of production.

⟨Fig. 2⟩ Classic styles Levi's 501® jeans, Classic boot cut jeans (Gap), Classic polo shirts (Ralph Lauren)

2. Collecting stage

At the design stage, feasible basic items through Life Cycle Assessment tools were chosen. The next process is to collect items from customers. For facilitating this process, retailers need to store customers' information such as what products customers bought and the date of purchase into their system. If they establish their customer's database, they would easily track clothing which items can be collected and redesigned. Then, they need to decide which incentives they can provide for customers. People are generally reluctant to return clothes. The survey conducted by Goodwill Industries found that half of the people making donations prefer door-to-door pick up, and more than half would not go more than 10 minutes out of their way to make a drop off. Since apparel companies are not recycling companies, it is not easy for them to collect clothing from customers by door-to-door pick up (EPA Office of Solid Waste, 2008). Therefore in order to lure customers into recycling events voluntarily, companies should use incentive strategies such as discount coupons or reward program which consumers can get bonus points or credits in returns for garments. Apart from encouraging more participation in recycling events from customers, incentive strategies can promote sales as well since coupons or points will be used in retail stores later. Rather than paper coupons, a web-based coupon is a green way for the environment in terms of saving paper resources.

After deciding which incentive would be provided, they need to formulate marketing plans such as advertisement for disseminating information. Since advertisements target only customers with items which companies plan to redesign, website or e-mail advertising is better than mass media advertising such as TV. Rather than website marketing, e-mail marketing is a form of more direct marketing as a means of communicating messages to specific customers. If a company establishes a mailing list, information can be instantly distributed to specific customers, and it

is easy to track. A company can track customers via un-subscribes, read-receipts, click-through and unread. Later, these can be used to measure open rates, positive or negative responses with customers' returning rate. Issuing a catalogue of "redesigned styles" through e-mail or website can act as a catalyst for causing more customers to participate in returning events. If customers see actual outcomes which will be reproduced from unused items they have, participating rate will increase based on trust in the concrete policy of the company. Then for an effective production system, companies sort used clothing by recycled status and size. Garments in good condition will be disassembled, recut, and reconstructed for new designs. Bad conditioned garments will be donated to charity organizations, sold in thrift shops at lower prices or exported to developing countries. Also, they can be sold by textile manufacturers which chemically or mechanically recycle them into new raw material.

3. Redesigning stage

By integrating recycled clothing into a new design, they can transform waste to fashion. Gary Harvey is a prominent contributor in this field. He designed his couture line by sourcing fabrics and raw materials
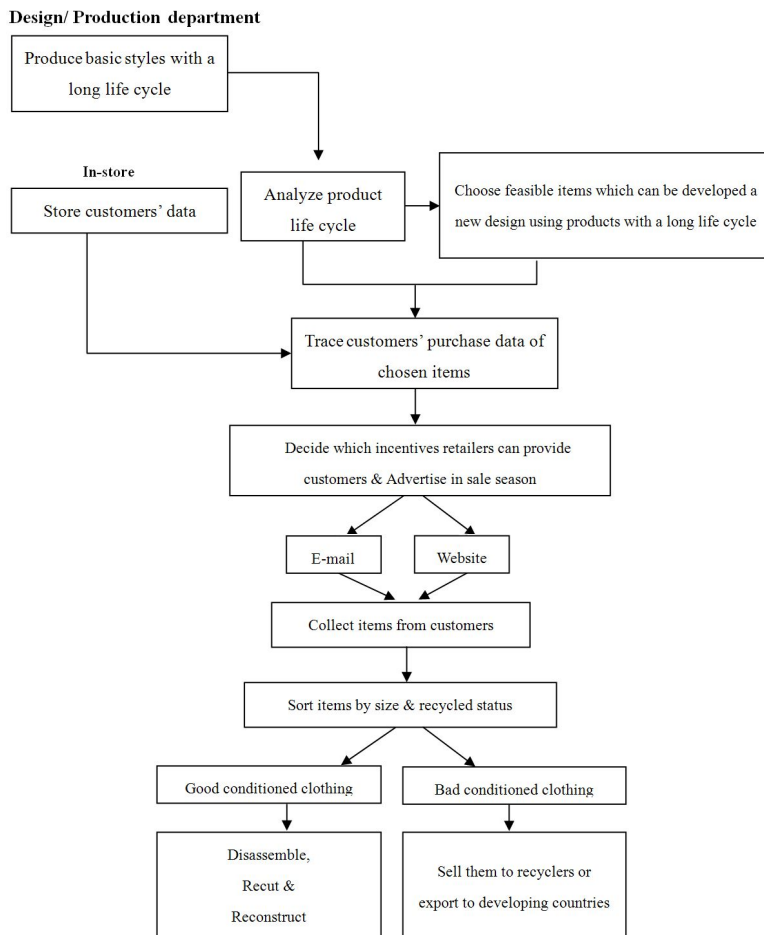
⟨Fig. 3⟩ The process of redesigning garment from recycled clothing

that have literally been thrown away. He made the first couture design using 42 pairs of Levi's 501® jeans. The challenge to create a couture-inspired dress collection using recycled clothing has grown from a simple past-time to a serious message that recycled garments can be made into something beautiful. So far, although these couture collections have succeeded in transition of our perception of second-hand clothing, they have not linked to consumerism but rather belonged to 'aesthetic of recyclability'. Therefore, it has to involve a radical rethinking of the grounds of fashion, ecology and consumerism.

The researcher in the current study proposed that new designs should fit for everyday wearable garments with affordable prices rather than unique couture design in order to increase consumption of reconstructed fashion by mass consumers. The proposed system intended create a "continuous-edition" line from abundant recycled basic items, whereas vintage stores or trendy retailers such as Urban Outfitters, operate a limited-edition line which sells a small amount of unique clothing because it is created by purchasing from individual designers or recyclers outside the company.

The first step of redesigning garments is to choose feasible basic items using Life Cycle Assessment tools from clothing designers already produce and sell. The next step is to redesign possible styles from items they choose. New styles cannot be largely changed from initial garments due to the nature of recycled clothing. Nevertheless, designers need to not only imbue their design inspirations into products, but also require absorbing tastes of the general public rather than toward uniqueness. In other words, sustainable design is not totally creative decision; rather it needs to favor mass-consumption and apparel object, not artistically led object.

Styles can be created in two ways: mixed style by combining different items or reconstructed style by disassembling and reconstructing one garment itself. In the production department, organizing a collection

of reforming methods according to each item and style is necessary in order to demonstrate in a very approachable way how to increase efficiency of the operating system and the industrial modes of production.

The proposed system in the current study intended to create a "Continuous-Edition" line from abundant recycled basic items. New designs should fit for everyday wearable garments with affordable prices rather than expensive couture designs with uniqueness. Therefore, as an example, the researcher in the current study chose boot cut jeans (# 488676) By Gap, which is one of the leading specialist clothing retailers in the U.S. with 5,500 stores, and a blue converse of All Star® for new designs. As raw materials, two items were considered appropriate for showing application of the proposed system, since their styles are basic and they might be collected with ease from customers due to being the best selling items in U.S. Based on a pair of jeans and a pair of Converse shoes, the researchers created two designs. The researchers cut the jeans into three parts; the top part is transformed into a skirt, and two parts on the bottom are transformed into a pair of knee-high boots, which soles are from the converse. If the researchers combine other recycled clothing with them, more diverse designs can be created. However, this study focused on how designs can be developed from limited resources. Therefore the researcher did not mix other recycled garments, but except for trimmings such as ribbons or eyelets. The process of redesigning the jeans and the converse spec is presented in ⟨Fig. 4⟩.

After creating new designs, only 4" × 9" fabric was left from the jeans. In terms of preventing unused clothing from ending up in the landfill, the proposed system can be considered successful for sustainability. Although new designs cannot be changed from initial garments due to the nature of recycled clothing, the redesigning process can draw attention from companies since they can save material cost per garment by generating two designs from one garment.
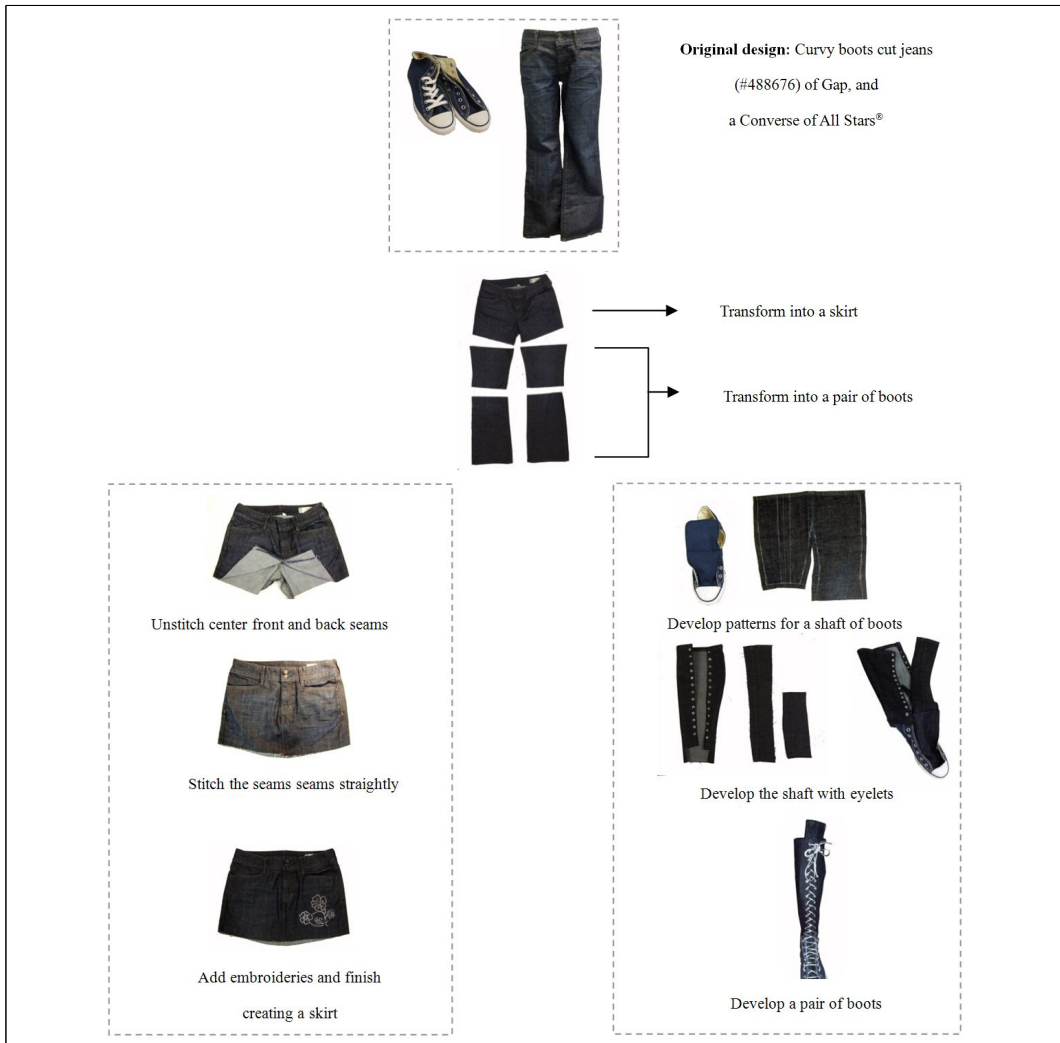
<Fig. 4> Proposed method of transforming re-valued clothing from recycled clothing

V. Conclusion

The International Standards Organizations (ISO) has defined sustainable fashion as identifying the general environmental performance of a product within a product group based on its whole life cycle in order to contribute to improvements in key environmental measures and to support sustainable consumption patterns (Claudio, 2007). The ISO is developing standards for a labeling system to identify garments that meet criteria as environmentally friendly. Beyond such specific standards for what constitutes an environmentally friendly, the apparel industry is also taking a broadening diversity of approaches for environmentally friendly garments at different levels from the fiber stage to production stage. However it is still fraught with uncertainty of systems in the industry.

This study focused on development of a system to make a new garment from recycled garments for large-sized retailers. While current recycling industries purchase recycled clothes collected by charities or counties, this system explored a way that retailers

directly collect their old clothes which they sold to customers before. Then this system presents a way to reconstruct old clothes. Although couture collections by Martin Margiela or Gary Harvey have succeeded in transition of our perception of second-hand clothing, they have not linked this to mass consumerism. The study proposed that new designs should fit for everyday wearable garments with affordable prices rather than expensive couture designs with uniqueness. It is expected to appeal to not only the public, but also apparel companies. Companies are reluctant to produce second-hand garments since they cannot sell products with cheap price due to additional cost such as recycling and production. However the application in the current study shows the possibility that second-hand clothing can be profitable since they can save material cost per garment by generating two designs from one garment.

It is important to establish systems for sustainable fashion industry. However the most important thing is a radical rethinking of the grounds of fashion, ecology and consumerism. If public awareness of the fate of clothing through its life cycle is not increasing, the system in itself is meaningless.

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