

Textile Science and Clothing Technology

Subramanian Senthilkannan Muthu
Editor

Models for Sustainable Framework in Luxury Fashion

Luxury and Models

 Springer

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*This book is dedicated to:
The lotus feet of my beloved
Lord Pazhaniandavar
My beloved late Father
My beloved Mother
My beloved Wife Karpagam and
Daughters—Anu and Karthika
My beloved Brother
Last but not least
To everyone working in the global luxury
and fashion sector to make it SUSTAINABLE*

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Eco-conspicuous Versus Eco-conscious Consumption: Co-creating a New Definition of Luxury and Fashion

Mukta Ramchandani and Ivan Coste-Maniere

Abstract Are consumers ready to pay a lot to be simple because they understand the value of sustainable products or is it just another means of flamboyancy? One might argue minimalism as a quest for a better quality of products yet being simple. However, the price paid for adorning such a lifestyle is coherent with affluent consumers. With support from in depth interviews and case studies, the current chapter presents the background on production and supply of fabrics made from recycled products. Additionally, within the realms of sustainable luxury we create a distinction between eco-conscious versus eco-conspicuous consumption.

Keywords Eco-luxury · Eco-fashion · Sustainable luxury · Minimalist consumption

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1 Introduction

Does the influx of environmental friendly luxury/fashion products serve the environment, protect the environments or is it just another means of a fashion trend? The answer to this question can be described in two ways. The first way is to access what purpose are these products created for. The second way is to access what do consumers see in these products that motivate them to buy it. In fact, with the recent decision of Gucci to go fur-free from 2018, the industry experts are curious to understand where the brand is heading. The company boss Marco Bizzari explains it's decision to be based on their values of sustainability and focus on environment, recycling, and humanity (Wightman-Stone 2017). Brands transforming towards sustainable luxury and fashion identity has envisaged into a larger trend. Is this trend the result of the conscious consumer advocating ethical consumption and attentive towards what they are consuming?

1.1 Minimalism

What is minimalism? Who or what are minimalists? What is the philosophy? Where is it rooted from? Where is it going? Such questions are on the rise ever since famous personalities like Mark Zuckerberg and Steve Jobs adorned the minimalist fashion wardrobe and showed the world that wearing the same design of clothes every day to work is in fact a style of its own and truly saving time when one has to make important business decisions. Companies like Everlane, Black Crane, Aritzia and others famous for creating minimalist design products are appreciated well by the consumers despite the prices being high for simplistic fashion. The minimalist products are somehow devoid of a wide palette of colors and mostly white or black, implying the use of it to be noble or something positive (Fagan 2017). Some argue it in terms of “buy less but good quality” or “save the planet by consuming less”. Others like the author Fagan (2017) describes, minimalist consumption to be another form of conspicuous consumption. As the consumers show that they can afford expensive simple products by paring one's life down as actively as possible but doing so out of being in a position of privilege and superficial simplicity.

But the real minimalist consumers are those that perhaps adopt the minimalist lifestyle out of their financial situation or a genuine concern for the environment rooted in their values not brought up through recent fashion trends. Taking the example of the environmental friendly products that have been existing for many centuries and have been used for its simplicity and cost affective factors. People in Asian countries like India, China, Japan etc. use jute and hemp based products for centuries. The simplistic lifestyle goes hand in hand with environmental protection in these countries. Similarly, Pineapple leather from Pinnatex is popular amongst the Nouveau eco-conscious consumers. Whereas, in the Philippines the pineapple based fabrics and leather has been used for ages.

The following sections in the current chapter inculcates the secondary resources and interview to provide perspective on the elements that influence the revival of certain sustainable materials and the motivations to use these materials by the brands and consumers. We also shed light on the production processes of some recycled and upcycled materials which are setting a new interest amongst the eco-conscious and eco-conspicuous consumers.

2 Methodology

For this chapter, we have used qualitative research methodology. Secondary data which also includes literature from various research journals and sources of information covering different points of view on trends of the industry like newspaper, journal and magazine articles. This also included several web sources such as blogs, online articles, company web sites and scientific reports. Additionally, the expertise of the contributors' long-term experience and existing relationships in the industry have been very useful. Interviews are one of the key methods to collect up-to-date information from the experts in the industry. We interviewed Daniela Milosheska the Founder and CEO of Bastet Noir based in Macedonia, giving us insights of prevalent questions for our research. Finally, we analysed the outcome seeking to identify the differences between eco-conscious and eco-conspicuous consumption.

3 Reviving the Past Through Eco-fashion

In this section we present how the textiles and fabrics that were used traditionally by consumers are revived presently by the companies in the name of "eco-fashion" or "greenwashing". Some luxury companies are shifting their brand image to that of a "sustainable or conscious brand", some innovating and exploring the recycled materials to produce textiles, and some upcycling the materials to create a new product.

3.1 Recycled Materials

Companies like Adidas, Patagonia, Levi's use recycled PET bottle fabrics to produce clothes. The textile fabrics are produced by shredding the bottles into flakes, which are then converted to small pellets, then melted, extruded and spun into a polyester yarn (Kavilanz 2016).

3.1.1 Piñatex™

Piña is a fiber made from the leaves of a pineapple plant which is commonly used in the Philippines for many years. A textile fabric is created by combining it with either silk or polyester ([Wikipedia.com](https://www.wikipedia.com), 2017). The fabric is mainly used to make clothes, table linens, bags, mats or other lightweight fabrics. The production includes the leaf first to be cut from the plant. Then the fibre is pulled or split away from the leaf. Most leaf fibres are long and somewhat stiff. Each strand of the piña fibre is hand scraped and is knotted one by one to form a continuous filament to be handwoven and then made into a piña cloth ([Wikipedia.com](https://www.wikipedia.com), 2017).

Inspired from the Piña and research in the Philippines, in 2013, Dr. Carmen Hijosa of Ananas Anam Ltd. Began to Develop, manufacture and sell pineapple leather called Piñatex™ from its head office based in London ([Ananas-anam.com](https://www.ananas-anam.com), 2017). The leather is made out of the fibres that are the bi-product of the pineapple harvest. Therefore, no additional water, land, pesticides or fertilizers are used to produce it. The company has been recognised within the fashion industry as a pioneer in the development of innovative and sustainable textiles. The company even has the “Vegan Fashion-label” from PETA. Since the pineapple leather Piñatex is vegan, biodegradable and recycled products, it was also used by Puma for their collection range of shoes and handbags which is appreciated and well accepted by the consumers. Dr. Carmen Hijosa states that the conscious consumers are taking responsibility for what they use and the consequences of using the products that we buy and use every day ([Goodnet.org](https://www.goodnet.org), 2016).

3.1.2 NewLife

A polyester yarn made from 100% post-consumer recycled plastic bottles and processed through a mechanical, rather than chemical, process in Italy by textile manufacturer Saluzzo Yarns (formerly Filature Miroglio). It relies on a patented horizontal integration system that involves a bottle-sourcing company, a materials convertor, and a textile factory. The end uses include fashion, sportswear, underwear, technical clothing, workwear, medical garments, outdoor clothes, furnishings, and accident-prevention textiles. It was used by Giorgio Armani to create an eco-friendly gown for Livia Firth at the 2012 Golden Globe Awards (Chua 2017).

3.1.3 Kibiso Story from Nuno

Nuno the Japanese textile brand has been committed to reducing waste from the spinning and milling processes. One of their projects include making use of kibiso, the protective outer surface of silk cocoons which is typically discarded as too tough to loom. Working with elderly women in Tsuruoka, one of Japan’s last silk weaving towns, Nuno started a kibiso hand-weaving project. These women set up looms in their garages and kitchens for extra family income, and made woven bags out of the

thick, stiff kibiso yarn, as well as hand knit hats. Today, NUNO has refined kibiso down to a thickness that allows automatic machine looming, resulting in a whole line of new fabrics, most of which have normal silk warps and kibiso wefts (nunoonline.com, 2017). The fabrics from Nuno have been showcased in many museums throughout the world and well appreciated by the industry and the consumers.

3.2 *Upcycled Fabrics*

Companies using upcycled fabrics are causing a new shift in the industry. For example—Frietag the Swiss brand uses materials like truck tarpaulins, discarded bicycle inner tubes and car seat belts to create one-of-a kind bag (Freitag.ch). Thus each bag unique to the other in terms of materials, colours and design. Consumers are mainly motivated to purchase Freitag products due to the environmental friendly aspect and the company's innovation with materials. Other factors include the products being water proof, long lasting and minimal in design.

Felder a German designer created a fringe-draped metallic skater dress composed of carbon fiber from BMW's electric-vehicle program. Inspired by the automobile maker's "i" series—and requiring more than 100 h to create—the "Carbon" dress gets its futuristic gleam from the same lightweight yet strong composite that clads the bodies of BMW's hybrid vehicles (Chua 2016b).

Similarly, American-Japanese brand Kirikomade creates patch work products made out of left over pieces of the expensive Japanese denims and other vintage textiles (Kirikomade.com).

4 Consumer Perspective

What makes consumers buy eco fashion products? What makes consumers adopt a minimalist lifestyle? Status or prestige seeking behaviour is classified as—conspicuous, unique, social, hedonic, and perfectionistic (Vigneron and Johnson 1999). In China for example many consumers buy luxury brands for showing off, and they focus more on "face" and social value in using luxuries (Li and Su 2007; Wong and Ahuvia 1998; Zhan and He 2012). But the younger consumers tend to stress more on the individual uniqueness and express it through the consumption so for them the value-expressive motivation is important in determining luxury consumption (Wang and Tong 2017). Therefore, it is imperative to note that the young Chinese luxury consumers will probably buy more sustainable eco-friendly luxury brands as it provides them more value-expressive motivation.

According to a research report by The Neilson Global Corporate Sustainability Report (2015) 66% of the global respondents are willing to pay more for sustainable brands, the influencing factors for 50% of them are the products made from fresh, natural and/or organic ingredients, a company being environmental friendly (58%)

and committed to social value (56%). The report highlights the fact that personal values are more important than personal benefits like costs or convenience. According to Landrum (2017) millennials prefer to spend their money on brands that have pro-social messages, sustainable manufacturing methods and ethical business standards.

4.1 *Distinct Motivations and Cultural Paradigms*

In the eighteenth century it was common for young women to learn how to mend clothes. These included mending linens and clothes to increase its longevity. In fact, during and after the world war it became a luxury to buy new clothes. The *Make Do and Mend* ethos flourished in France, the United Kingdom and the United States in the 1940s. The Make Do and Mend message was advertised by governmental campaigns as a patriotic duty. It was promoted through numerous booklets, posters and magazines that shared tips and techniques to remain stylish, repair materials, and make old new again (Gordon and Hill 2015). The mending practise has become active again recently through social medias and repair cafes. The practice has particularly regained momentum in the UK. Tom van Deijnen, Brighton-based author of the blog Tom of Holland and influential advocate for the cause, explores woolen garments' life cycles by using traditional repair techniques. His Visible Mending Workshops are very successful as he "an emotional link between the wearer and garment." This new aesthetic that mixes old and new, vintage and remodelled garments, is an answer to standardization and a source of inspiration for designers (An Berthon 2017).

The Japanese have a term that describes their sense of thrift: *mottainai*, "don't let anything go to waste." Muji a Tokyo based clothing and lifestyle brand known for its no-frills, egalitarian designed goods, takes to heart this philosophy, particularly with its "Re-Muji" project, which takes customer castoffs and over dyes them in myriad shades of indigo for resale. The company decided to go further with its new line of garments and accessories derived from reclaimed wool, a textile that Meiji-era Japanese would have been more than familiar with. With scant success raising sheep despite the influx of Western influences, 19th-century artisans often collected used imported woollens, washed and sorted them by color before shredding them for reconstitution into new thread (Chua 2016a, b).

In India and Bangladesh, the craft of Kantha is indigenous amongst the women to make a DIY quilt, textiles and pillow covers etc. from old Sarees. The clothes are sewn from the old sarees and is also used for borders of the sarees which are then handstitched. Historically, kantha textiles have used a form of the running stitch, called the kantha stitch. It consists of a line of small and even stitches running through the cloth without overlap. The simplicity of the kantha stitch is organic to the objective: to repurpose old clothing into new products without wasting resources (Nasim 2016). The trend to use the left over fabric pieces is not new. In fact, the hand woven cotton fabric from India known as Khadi is used for creating sustainable clothes as well as supporting the local skill (Wikipedia.com). The Khadi use was even popularised by Gandhi during India's freedom struggle against the British rule.

4.2 *Eco-consciousness Versus Eco-conspicuousness*

Eco-conscious is defined by the Merriam Webster (1972) dictionary as “marked by or showing concern for the environment”. Therefore, consumers that consume environmental friendly products due to their genuine motivation for the environmental concern are eco-conscious consumers. Similarly, we shed light on the term of “eco-conspicuousness”, meaning showing concern for the environment due to a conspicuous motivation. Hence, the consumers that consume environmental friendly products due to conspicuous motivations like status, prestige, conveying their image etc. are eco-conspicuous consumers.

Why do we need to study the eco-conscious and eco-conspicuous motivations? It is because currently the demand for environmental friendly luxury and fashion products is increasing and with the demand there is a responsibility for the brands and researchers to educate the potential consumers. Additionally, when the distinction between these motivations are presented, it will get easier for brands to strategize, manufacture products and streamline the brand communicate.

Several questions arise here are eco-conscious or eco-conspicuous consumers willing to pay more for an eco-friendly product? Are consumers more eco-conscious or eco-conspicuous or both depending on the brand influence? The greenwashing communication reflects more on the eco-conscious appeal or the eco-conspicuous appeal? For example, buying a Stella McCartney product (famous for being eco-friendly) might be bought by a consumer for its utilitarian aspect and probably intrinsically justifying to themselves as consuming luxury while saving the world. But Stella McCartney being a luxury brand is also perceived as a status symbol. Therefore, on an extrinsic view, the eco-conspicuous motivation could be highly signalled than eco-conscious motivation in such a case. On the other hand, if a consumer buys a hemp t-shirt from an independent company it signals more the eco-conscious motivation than the eco-conspicuous motivation, unless the hemp t-shirt is produced by a major luxury brand.

As described by Carrington et al. (2016)—The consumer turns their consumption into a concrete articulation of satisfying their superego in order to do the impossible i.e. to enjoy, provide, realize, be authentic but also recycle, protect workers in China, prevent illegal arms trading, end the killing of animals etc. all in order to save capitalism from digging its own grave.

5 Interview

The following section presents the interview questions and answers with Daniela Milosheska, Founder and CEO of Bastet Noir in Macedonia.

(1) What is causing the trend towards minimalist fashion?

In my opinion it's because honestly as a society we're fed up with too much going on around us, so probably one of the reasons why our generation is so in love with minimalist fashion is the fact that it's simple, comfortable and easy. Another reason on top of my head is that it reminds us of the future, as white for instance is usually used in sci-fi movies and with everything going on with AI nowadays, we probably associate it with that sterile setting in the movies.

(2) Consuming a minimalist luxury/fashion product is a sign of environmental consciousness or is it just another means of conspicuousness?

I don't think environmental consciousness and minimalist fashion has anything to do with one another.

(3) Can this trend towards minimalist fashion be predicted to be long lasting? Why or why not?

According to me, minimalist fashion is more of an aesthetic than a trend. So yes, the aesthetic is a long lasting one, because before minimalism became a trend, there were always people like Coco Chanel or Jane Birkin that were rocking this effortless style, as I'm sure, long after it stops being a trend, it will still be sort of like an aesthetic that will always be closely associated with luxury.

(4) In your opinion is there a link between minimalism and eco-consciousness?

No, I don't think there is one.

(5) Recently textile products made from Recycled PET bottle fabrics and pineapple leather are attracting consumer attention. What in your opinion is causing brands to shift towards using recycled materials?

I would say environmental changes. In my opinion is probably the biggest cause for the reason why brands are shifting towards recycled materials.

(6) In your opinion are people willing to pay more for an environmental friendly luxury/fashion product?

In general I think this isn't the case, as I believe that most of the people aren't being conscious about environmental changes. I believe there's a long way to go first in educating people on the subject, so they can start paying more attention to environmental friendly products.

(7) Can you give some examples of companies that are mainstream in minimalist fashion products?

ACNE Studio, Roksanda Ilincic and most of the Scandinavian brands I think are the most suitable representatives of minimalist fashion.

(8) Can you give some examples of mainstream environmental friendly luxury/fashion companies?

Probably Kering Group with Stella McCartney being their number one environmental friendly brand.

(9) Does the demand for environmental friendly luxury/fashion products vary by country?

I think it does, mostly because it takes a highly civilized society with educated individuals to generate a demand for environmental friendly products.

(10) Besides the manufacturing of environmental friendly products, how should the small companies/designers attract the potential consumers?

I believe that for small companies and independent designers, the future is in custom made fashion. Those companies which will make one of a kind products that tell stories rather than sell quantities will most likely be successful.

6 In a Nutshell

The current chapter sheds light on the sustainable fabric productions of various luxury and fashion brands. The motivations for these brands to manufacture sustainable products and what factors lead the consumers to purchase these products are presented. With our findings from the secondary research and the interview, we predict that the quest for sustainable production and consumption will continue to grow. The more educative the luxury and fashion brands become, the more steadfastly the change will occur in the consumer mind-set. Especially in countries where already the consumers are more educated on the environmental impacts of their consumption and with the rise of sustainable companies. Even though the minimalist fashion lifestyle at present is indirectly associated with consuming less to protect the environment, there might be not a direct link yet with the environmental friendly materials used. However, it creates an open ground for creating a unique paradigm shift in luxury and fashion industry. Within the subjective definitions of ethical, eco-friendly, sustainable luxury and fashion, it is difficult to clearly predict whether the eco-consciousness or eco-conspicuousness will be long lasting or be seen as simply a trend in the future.

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Innovation and Sustainability in the Luxury Fashion and Fabrics Industry

Ivan Coste-Manière, Paul Charpentier, Gérard Boyer, Karine Croizet, Julia Van Holt and Sudeep Chhabra

Abstract The global textile and fashion industries represent one of the most polluting and waste-generating sectors in the world. The ecological impact is seen through the different steps of its product's life cycle: "from fibre growth and manufacturing, dyeing and printing, transportation to stores and selling, to end of the garment life disposal" (Hill and Lee in Young generation Y consumers' perceptions of sustainability in the apparel industry, 2012). Kaye (Textile recycling innovation challenges clothing industry, 2011) in his article (available at theguardian.com) displays very clearly the current ecological situation, highlighting the fabrics and fashion industries' role. He explains that fashion becomes more and more affordable these recent years, thanks to big branches such as H&M, C&A and Inditex (Zara's owner). Nonetheless, this "cheap fashion" has a price that is paid by the planet earth. According to Kaye's article (2011): "it takes 8500 litres (2245 gallons) to raise 1 kg (2.2 pounds) of cotton lint—enough to make one pair of blue jeans". Water with chemicals, clothes waste and sustainable raw materials are the major ecological issues seen through the overall product life cycle. Nowadays, companies are

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realizing the importance of sustainability in these sectors and are trying to find solutions mainly through innovation. However, firms are finding the limits of sustainable processes. The most famous examples are the companies using PET bottles to recycle them into fabrics. Unfortunately, this recycling process has its limit because once the material has been once recycled, it cannot be recycled a second time. Another major barrier is the lack of recycling education and solutions for consumers: “only 48% of post-consumer used clothing is recycled (Chen and Burns 2006)”. The fashion and fabrics industries have serious ecological concerns they cannot afford to avoid any longer. The main goal of this chapter is to reach a holistic point of view of what is the current sustainable situation in the fabrics and fashion industries (through the product life cycle steps and the stakeholders); to draw future trends and possible solutions in these sectors. In order to do so, the study will also look at market studies to understand the country’s economic reactions to these new markets. A special focus is given to the following: (1) the importance of sourcing, (2) the retailers point of view, (3) the customers point of view, (4) the Y Generation concerns, (5) different sustainable organizations, (6) COP 21 encouragements, (7) the Smart textiles solutions, (8) two kind of market examples, (9) the future of sustainability in the luxury fashion and fabrics industries, (10) the limit of the sustainable model, (11) Sustainable innovation examples.

Keywords Fabrics · Fashion · Sustainability · Innovation · Ecological footprint Ethic · Recycling · Regulation · Transparency · Eco-friendly · Product life cycle and technologies

1 Introduction

Fabric is a name given to materials that can be weaved together. Initially, this material can be divided into fibres or textile yarn (Duden 2017).

Weaving is an ancestral activity that went through history. It is so old that there is no precise date at which it was invented. Weaving has always been a big part of the trades within and between countries. The reason of this importance is that weaving and fashion are two bounded industries that respond to basic needs. These needs evolved through history and the fabrics followed this evolution. Additionally, innovation and fashion collections have created new needs and use of fabrics for customers; enhancing the size and importance of these industries. Nowadays, clothes are much more important than just responding to basic needs; they are a certain commitment, statement from the consumer.

However, this continuous development has its limit: resources. In the current ecological situation, the fabrics and fashion industries are put under the spotlight and has to respond. Innovation is the main answer that the industry is giving (using new raw materials; creating new process of production or distribution...).

On the other hand, The United Nation Environment Programme report doesn’t feel that the industries’ efforts are sufficient; explaining that the clothing supply

chain causes heavy damages to the earth. The ecological impacts are seen through different elements such as: raw materials, water, energy, climate change, waste, chemicals, disposal and many more... Focusing on chemicals, manufacturers have to be more careful through the production processes: fibre manufacturing, processing, finishing and dyeing.

Indeed Hill and Lee (2012) agreed explaining: “The apparel industry has specific negative impacts on the environment through all stages of the apparel product life cycle”.

In the ‘just style’ green-report (2013), an interview of Sarah Ditty from the ethical fashion forum explains that sustainability in resources can be a synonym of cost savings for firms. Talking as an example firms that used sustainable resources and realized how profitable it was. This statement outpoints an opportunity on the fabrics and fashion markets.

This continuously evolving industry is full of unpredictable changes. Manufacturers used to be asked to make wrinkle-free, smell-free, skin friendly and elastic fabrics. Nowadays, the close-up is shifting to product quality, sourcing and ecological impact. As an example, sustainable fabrics and fashion used to be seen as “Hippie clothes”; the current perception of these apparels is trendy and responsible clothing. The customer perception on sustainable fashion and fabrics went from cheap to chic.

Finally, within these sectors everyone has its role or mission; from the manufacturers to the customers passing by the distribution and retail stores. A new market is being created and this report aims at reaching a bird’s eye view of the current situation, in order to draw future trends and solutions.

The main issue is to be sure to dodge the green washing and bashing borders. From the sourcing of sustainable fashion firms, to some changes in the distribution channels current rules, while keeping in mind both the retailer’s power and the customers’ point of view, this chapter aims at analyzing the updated regulatory issues in US, EU or UK, redefining the frame of a topic which is melting together technology, branding, law, finance, pricing and retail, psychology and customer behavior.

2 Methodology

This chapter is taking into account ecological issues from the fabrics and fashion industries in which sustainability and innovation are the two major visible solutions for the future. In this report, we are trying to reach an overall and current point of view of these industries. Considering different visions that are linked with the product life cycle steps, such as: customers’ vision, firms’ vision, government missions... The final objective is to understand the current situation and draw future trends and solutions. In other words, our main goal is to reach a holistic point of view to get a broad and precise understanding of these industries. From this point, we will outline the future trends and solutions for a sustainable market in the fabrics and fashion industries.

In order to do so, the report will use: countries' industry reports, market analysis, journal articles, interviews and green business reports. These different kinds of sources allow us to reach the broad understanding we are aiming at. Additionally, to the theoretical reflexion, the two countries industry reports permit us to understand (economically speaking) the impact and importance of such industries. However, sustainability and innovation have their limits and we are trying to understand them. Finally, this progressive thinking is made to understand future trends, solutions for the industries.

3 Literature Review

3.1 *Sourcing for Sustainable Fashion Firms*

Newbery (2011) is stating that there is a 40 years' tradition in the apparel industry to source into the "lower cost countries". Some believe that this process is knowing its limits because fewer and fewer countries are still cheap producers (e.g. China and its rising production costs due to new positioning on innovation). This phenomenon is due to the fact that massive investment into manufacturing countries develops them year after year. At a time, these countries reach a point where there are not cheap enough for firms that move to other countries. Having a long-term vision, this philosophy is no longer profitable.

Additionally, Mike Flanagan (June 2011) confirmed this claim, stating that in China "during the five years since 2005 in which it has become the world's largest supplier, wages have got more, rather than less, expensive compared to rivals like Bangladesh." He also explains that China has never been the "cheapest producer" but it was chosen by all international firms for its efficiency, reliability and the small premium (comparing to other developing countries).

We have just seen above that cost is the number one reason that drives nowadays buyers. This race to the cheapest and most effective bargain has overlooked the environmental question. These low costs of production permitted retailers all over the world to respond to the increasing demand of "cheap fashion". Within the western fashion industries, Offshoring and outsourcing is something common (Goworek 2011). For instance, clothing from Asia achieved a 95% market share on the UK market in 2005; previously 74% in 2000 (Key Note 2006).

Goworek (2011) explains that the principle issues with sustainability and mass production of clothes in developing countries is: the use of pesticides, use of water and dyeing the fabrics. Additionally, volume of disposal and working conditions are very bad. In order to be transparent and change these negative effects; it has been created the CCC (Clean Clothes Campaign) with a global range of action. This will ensure consumers the environmental cleanness of their purchases (Clean Clothes Campaign 2009). There is a UK version of the CCC which is "The labour behind the

Label". The UK retailers also made an alliance to reach a better quality of production; it is called the ETI Ethical Trading Initiative (Ethical Trade Initiative 2009).

However, better indicators of the growing awareness for socially responsible retailers are investigation groups.

CSR sourcing is defined by suppliers' transparency. However, international suppliers have so many manufacturers and suppliers involved that it is hard to have all of them with the same ethic. In that reason, an important way to avoid any surprise from a supplier is international contracts. They are a common and legal way to bind to parties to respect some obligations. An important clause is the "non-assignment clause" obliging a party to do itself a certain task. There is no possibility it has been made by another supplier. This clause is very important in the CSR case because buyers often visit their supplier and need this special supplier to produce a certain way; with a certain ethic, working condition and raw materials. They don't want any other subcontractor to do it (Daloz 2016).

Looking at the retailers, researchers proved that 43% of the retailers that had visited their manufacturers found child labours. In that reason, it is even more understandable that retailers really commit to ethic purchasing; following guidelines in order to involve with the welfare of clothing workers.

Fair trade is a well-known method of doing ethical, sustainable business; insuring a fair income for the producers and discussing the production method and quality with them. Fair Trade is based on transparency between business partners to create long-term relationship. Moreover, because of the nature of the relationship; it is sustainable.

Jones and Comfort (2005) realized that the financial, social and environmental benefits of fair trade are supported by recent CSR major retailer policies. Fair Trade is no longer to be proven and is spreading through the luxury fashion and fabrics industries.

Newbery (2011), also approaches another view of sustainable sourcing. Explaining that a major environmental unfriendly factor is the transportation. Goods are being bought a shipped from a side to the other of the planet. That is why, locating the production close to where are raw materials is a philosophy of taking a step toward sustainability. This argument is applying for China, Turkey and India.

A good example of close sourcing of raw material to the production location is the United States and Denim manufacturers. For instance, Santana Textiles is producing Denim fabrics in the United States and is using Texan's cotton as raw materials. This home market business helps to develop the national economy and fight unemployment. As an example, this company is the cause of a storage warehouse and 800 employees. A philosophy is clearly demonstrated; sourcing means manufacturing employees and investment lost abroad (Newbery 2011).

To conclude we have seen that sourcing is a long process seen through different actors; from the manufacturer to distributors, passing by the supplier and the buyer.

Sourcing is defined by the transparency of many aspects such as: raw materials, production methods, labour conditions, money sharing; and a recent awareness is developing around the transportation impacts. This new awareness argues in favour

of re-industrialization of developed countries (or at least close to their borders); highlighting the importance of regional trade agreements (Newbery 2011).

3.2 The Retailers Point of View

Sustainability is a question to be studied along the product life cycle, in order to get a better understanding of the environmental impacts of the fabrics and fashion industries. A step often forgotten is the retailers' impacts but more importantly their missions. Indeed, retailers are the ambassadors, the windows of what is sold inside. Their missions are clearly to embody and spread each brand's message with clearness and transparency.

Retailers are a key success factor while speaking about fair-trade. Retailers will ensure the safe working conditions in factories, check the wages, indirectly employed artisans in developing countries and check the recycling of fabrics waste into raw materials. The retailers have a strong involvement because they have a distribution role and a direct contact with the customers. They are the face and brand seen by the clients; moreover, retailers have an advising role and have to be knowledgeable. A key factor for retailers is not just fair trade products. In fact, transparency will make retailers more successful; customers are looking for trust.

In other words, retailers do not have a strong direct impact on sustainability. Nonetheless, their role of ambassador, information spreading and educating the consumers is very important for the luxury fashion and fabrics industries to be transparent. Retailers' impact is indirect but so much important as it is the link to the most important stakeholder: customers.

Goworek (2011) focuses on the direct impact from retailers on sustainability. Explaining that the retailers' role is seen through CSR policies (corporate social responsibility) and their code of conduct. This CSR directly affects the retailers' actions, thus having a good CSR involvement will positively affect their profits. However, we must not forget, that CSR is always a voluntary tool to integrate within the retailer's strategy. This means on the good side, that retailers do more than legally necessary, but at the same time, there are no guidelines or corrections towards those actions (Meffert et al. 2012). Additionally, and according to Goworek (2011), retailers will lower their operating costs thanks to renewable sourcing, brand image and market operations.

3.3 The Customers Point of View

We strongly believe that consumer's behaviour is a key success factor for large "environmental gains". Explaining, that consumers are becoming more and more educated; realizing the importance of an action as consuming. Indeed, customers have an increasing sensibility to sustainability, especially in the fashion and fabrics

industries. Consumers also want to know more; as the conditions in which apparels are made. Additionally, customers require the truth, transparency and CSR is once again stated as a key. Most of them are loyal to national brands but more and more are switching to environmental aware brands.

Therefore, consumer's behaviours have a strong impact on the clothing industry, including purchasing, using, caring and finding recycling disposal. If the customers have an increasing awareness and education about the fashion and fabrics industries, there are still important unsustainable behaviours to highlight.

In other words, people have still to be educated and taught how important is sustainability for future generations. A big misunderstanding remains on how to educate customers and the importance of clothing labels. According to Black (2008), clothing labels are inadequate to inform the "average consumer" concerning the whole product lifecycle. On the other hand, sustainable standards and certifications are accepted. Goworek (2011), speaks about a real confusion among consumers' mind. Clothing label is just not really believed. A real issue is the fact that consumers have to be educated about the differences between: "green consumption, ethical consumption and voluntary simplicity".

Price is a very important factor that influences the consumer behaviour; it is even more crucial for the sustainable market. The value attached to the product is defined by the consumer's willingness to pay; this willingness is defined by the perceived value. Sustainable clothes have a high-perceived value by customers so they are ready to pay a premium for it. Young et al. (2004) even add that consumers have a real ecological consciousness on their purchasing decisions. However, if a product is too expensive some consumers will not be able to afford it. In this situation, the process is not sustainable. In that reason, price becomes one of the sustainable production biggest challenges.

In a few words, nowadays consuming is not just a matter of fulfilling traditional needs. Consuming has an ethical, involvement and statement role. Customers are responsible (if they can afford it) to pay a premium and consume quality sustainable product instead of quantity consumption. Additionally, ethical consumerism is currently important and it supports the sustainable fabrics and fashion industries. S. Ditty from the UK based Ethical Fashion Forum agreed stating: "I think consumers are definitely interested in their environmental footprint but it's just such a shallow level of information available to consumers". A lack of communication could lead in result to a lack of authenticity of the whole brands communication (Meffert et al. 2012).

Focus on the customers' perception has come to the conclusion that the sustainable fashion industry has not reached the "tipping point". Sustainable innovation in the fabrics and fashion industries has many other innovations. Indeed, within the innovation adaptation process, consumers are instruments. Clients have to get use to the sustainable fashion for the brand to achieve a new paradigm.

In order to conclude, all of these influences are based on the consumers' perception, which is the cause of the purchasing action. This purchase can be classified into two main types of consumer's values: environmental and materialism.

3.4 Young Generation Perception of an Industry Influencing Their Future Life

This part take a deep insight at the Hill and Lee (2012) report; directly related to this sub-part.

First of all, the young generations also named generation Y are people aged 18–35 in 2012, who are especially socially concerned and aware of many global issues. These consumers are highly connected to a lot of diverse medium means. This connection is mainly made through social networks, Internet browsers and websites, as well as traditional communication means. Hill and Lee (2012) explain that this intense exposition to advertising messages is confusing the young generation's perception of sustainability. Indeed, messages contradict between each other and the consumer does not know whom to believe.

Even if the young generation has a high exposure to information in general; messages must be very confusing or not reaching any attention. In fact, an investigation on knowledge concerning sustainability held by this generation has been mad. Results have been showing that very limited knowledge are held; more precisely concerning the apparel industry.

More generally, all the consumers and not only the young generations; studies have considered the effects of consumers' knowledge and concern about sustainability. Their concern is truly affecting their consuming behaviours.

The Y generation is representing a long-term powerful segment of consumers. Young generation people are born between 1977 and 1994. They are sceptical and concerned consumers (Jayson 2006; Williams and Page 2011). This sceptical mind-set came from all the accessible information they have (on Internet and else where). In that reason, Williams and Page (2011) explain that the young generation is aware for natural and human initiated disaster worldwide. This concern is traduced by a general willingness to take actions. However, as Gam (2011), Kagawa (2007), have explained, Y generation knowledge of sustainability is very low but they have a high interest in it.

There is a real duality within this generation and this is the reason why information has to be brought to them with transparency. This will match they desire and awareness; feeling comfortable, trusting a certain firm. For instance, retailers or information tagged on the clothes can have this function of bringing transparent info to the consumers. Moreover, the best way for consumers to be more willing to have a responsible behaviour is to make them feeling their positive environmental impact while consuming certain products.

Finally, consumers in general have different perception that will direct their consuming behaviours. All firms' biggest desire is to create strong bonds with the customers; thanks to transparency, communication or common believes. Sustainability and Young consumers concern about it, linked with a lack of knowledge; offers to the firms a big opportunity in terms of CSR involvement and new bonds creation. CSR is a source of Y generation consumer's commitment (who are long-term customers) and company should use this positioning, involvement as a tool to reach new

long term and loyal customers. In order to do so, companies also have to match the sustainable definition this generation have in mind: long life product, conservation and environmental considerations.

3.5 Sustainable Measures: The UK Example

Adopting a sustainable, ethical behaviour in the luxury fashion and fabrics industries is already pressured by the market trends and costs saving possibilities. However, market change is a long process that if happening will be seen on a long-time perspective. In order to speed up the process governments and groups are putting an additional pressure thanks to the legislations, pressure groups, action plans, etc. The Government main aim is to reach higher regulation of these markets; mainly thanks to waste reduction and recycling (So 2013). In that reason, British companies are watching closely the DEFRA (the UK's Department for Environment, Food and Rural Affairs) actions as this department wanted to ban textile waste (Ditty 2013).

The United Kingdom is an example concerning the numbers of measures and actions taken to regulate the clothing industry. In this part, we will display the major actions taken on this market to be more environmental friendly.

European Union Principles

Newbery and Ghosh-Curling (2011) in just-style green report explain that in the UK, the fabrics and textile industries are expected to grow. In fact, the EU legislation realized a new lever to pressure on non-sustainable firms; they classified textile as "priority waste stream".

The EU legislation general principle concerning recycling general waste is to make it accessible for all firms and citizens. However, Europe still has to decide at what stage waste are considered as materials to be recycled. Indeed, recycling can take different forms and more especially in the textile and fabrics industries. Recycling can produce yarn or fabrics from plastic bottles; for others recycling means reuse of textile waste. Additionally, the finished good, apparel can be used and reused thanks to the second hand market (Newbery and Ghosh-Curling 2011).

British Fashion Council

The council is a strong believer that being environmental friendly and making profit are coherent activities. In order to do so the council discussed four areas. The first one is the fact that goods have to be "well-designed and compete with other mainstream products". Secondly, the coordinated marketing campaign would support the sector. The third area is the challenges of having a good selling price and being sustainable; any government incentive is a real push. In the last area, the British Fashion Council speaks about giving incentives aiming at more ethical designer or Fair Trade and recycling products.

The final result, is that the council decided to take action; calling for tax breaks. The main point is to make the government react and show them that more affordable

sustainable products would help sustainable fashion and fabrics industries on the long-term run.

SCAP—The Sustainable Clothing Action Plan

This action plan is uniting the different parties: government, the industry and pressure groups. Nonetheless, its diversification is also an obstacle during the decision-making process: not all initiatives meet approval from all parties (and all approvals are required to take actions). The SCAP is supported by 300 organizations from manufacturers to designer, passing by retailers.

For instance, it planned on the 21st February 2009 “to make clothing more sustainable and less environmentally damaging”; coinciding with the fashion weeks’ dates. They also have linked retailers with charity shops; “recovering 4 million garments last year”.

CSF—The Centre for Sustainable Fashion

CSF is based at London College of Fashion, is a study and consulting groups that aims at impacting the industry; working sometimes with firms or realising papers and studies. Their last realize is: “reference work, setting the research agenda for the field for the next decade” (CSF official website: Our Story, 2015).

EJF—The Environmental Justice Foundation

This Foundation believes that “environmental security is a human right” (as stated on their website). They also are stating that “a degraded natural environment means hunger and brutal poverty that costs lives”. This foundation is deeply involved into sustainability and is denouncing any kind of unethical behaviour.

This foundation has experience with institute such as the United States Congress, the European Parliament, the European Commission and Governments. They have been part of the Montreal protocol or even the United Nations Commission on Sustainable Development.

CCC—Clean Clothes Campaign

CCC is an international organization that supports working conditions of employees within the footwear and clothing industry.

CCC has multiple divisions around the world and the ones in the United Kingdom are named “The Labour Behind the Label” and “ETI—Ethical Trading Initiative”. They have formed an alliance among UK retailers. The common goal is to enhance working condition standards in the clothing industry.

3.6 COP 21 Incentives

This meeting was very important for the luxury fashion and fabrics industries as it highlighted the importance of these industries’ waste, pollution and emission. This

meeting draw his interpretation of what is the current global situation ecologically speaking. Below we will analyse it and see what engagement has been taken.

The BoF web journal (Business of Fashion) 2015, explain that the COP 21 that occurs in France has reunited 195 countries that all aim at one common goal “cut emissions”. In other words, this international meeting has been built to develop the international concerns about the economics’ impact on the environment. COP21 proposes agreements that are negotiated and discussed for a period of time and ratified (by the country that agrees) at the end of the week.

The result of Paris’ COP21 is a deal that should be effective in 2020. It ensures that countries will take into actions the necessary actions in order for the global warming not to exceed 2 °C. This level is mandatory because it would be a disaster for the whole planet earth “extreme weather, accelerated melting of the polar ice caps and dangerous rise in sea levels”. In that reason, the additional aim is to reach an additional 1.5 °C (Business of Fashion web article, 2015). The COP21 number one concern is the industrial countries and their emissions. Typically, these countries are China and India; big cheap fashion suppliers.

Concerning the luxury fashion and fabrics industries this agreement is setting a mark toward “low carbon economy” is stating Hannah Jones (chief sustainability officer at Nike in Business) Fashion web article (2015). For instance, this agreement is forcing firms belonging to the fabrics industry to change their production methods in order to reach more sustainable processes. Indeed, production of fibres or yarns such as cotton or cashmere requires a huge amount of energy and water (Business of Fashion 2015).

The other big impacts from the fabrics industry that has been approach are the transport and logistics impacts. In facts, customers have to understand and take into account that when consuming certain product, they are supporting a certain method of production rather than another one (Business of Fashion 2015). Consuming is a committing and supporting act.

The COP 21 also highlighted the importance of product and raw material traceability within the fashion and fabrics industry. The idea is for the final clients and retailers to be a hundred per cent sure of the product composition and where does it come from. In fact, because a product (from the farmer to the retailers) passes between so much hands; it is hard to trace all the composition steps (Business of Fashion 2015).

3.7 Smart Textiles

The smart textiles, also named e-fabrics or electronic fabrics are literally capable of analysing signals and give a response trough the fabric itself. There are many use for smart fabrics such as: medical, spatial projects, protection, sport, military, design, fashion, music, 3D etc.

In this chapter, we will only focus on smart fabrics linked with the fashion industry. Smart textiles are often described as a material capable of responding by itself or adapting to its environment.

In order to do so; these fabrics are made with informatics, numerical or even electronic particles. The only problem is to find a new use for fabrics; then create (e.g. thanks to chemistry) the perfect blended mix between fibres and added particles to respond to this need. This new introduction of chemistry within fabrics opens up a new world of innovations that is booming.

Gaddis (2014), (available at Forbes.com), agreed explaining that smart textiles have technology(ies) within and are providing to the consumer an added value. She also explains that the major force, competitive advantage of this industry is smart textile. They are doing things traditional fabrics cannot do such as communicating, performing or transforming. She also divides this industry into two main categories “Aesthetic and Performance enhancing”. Aesthetic will use more optical fibres to light up or change colours; whereas performance-enhancing will mostly impact the sport and military industries. Sport performance items are not just apparels that are very comfortable, elastic and keep your warm; they are also apparel that control muscle vibration, gather environmental energy and will reduce wind resistance.

Looking at the possibilities given by smart textiles, it is understandable that it is seen as the major trend and future solution in sustainable luxury fashion and fabrics industries.

3.7.1 Performance Apparels

Having a look in the past, the first technology and battlefield that have been democratizing smart fabrics were sport performance apparels. These apparels are providing the owner advantages such as: extended elasticity, second skin feeling, regulated heat, faster drying and softness. Nowadays, sport performance apparels are something very common but it defines how smart textiles got popular. Frastaci (2000) in her article *High tech fabrics meet high fashion*, explain how synthetic fibres are “beyond hard core athletics”. M. Frastaci is detailing how sport performance apparels are becoming so popular on the world market; even penetrating the high fashion industry. She described this fabric as “active wear” thanks to the “comfort, performance, function” these clothes are providing.

Nonetheless, smart technologies have quite difficulties to enter the high fashion regarding the little number of designers using these technologies (Gaddis 2014). This number might be small but is notable. For instance, Ying Gao (fashion designer) is using sensory technologies in his creation to make it more interactive.

Every new technology and innovation is bringing smart textiles to another level. Only the future will tell us how far it can be developed. However, experts all agree on one point: smart textiles and sustainability are key success factors for the development of the luxury fashion and fabrics industries all over the world.

3.7.2 Optical Fibre Fabrics

Optical fibres and Nano technologies (discussed in Sect. 4.7.3) are representing a brand-new trend and future possibilities for the sustainable fabrics and fashion industries. Its new properties offer unknown possibilities in terms of design creation and environmental footprint. As Youngjoo and Dong (2013) said; these two technologies are “key solutions” for the future of these industries.

A very interesting strategy is the use of environmental friendly material. These materials can be natural fibres, recycled fibres, biodegradable fibres but and can also come from innovation.

What is done is the optical fibres are introduced within the fabric itself while weaving. The optical fibres have the advantage of being resistant and flexible; at the same time, they offer a sublime optical effect. At the moment, fabrics with optical fibres are mostly used for decoration but some fashion designers started to create with this new material and when the LEDs light up; designers clearly have a new means of expression. The most recent example is the “Cinderella dress” worn by Claire Danes (‘Homeland’ series actress) and designed by Zac Posen, that lights up the Met Gala in New York (May 2016, available at the nypost.com). The gown was developed in a way, that you cannot see the technology behind it, when wearing it by daylight. It reveals its ‘surprise’ only in the dark. That is why Danes posted its effect in advance on her social media channels, shared a thousand times.

3.7.3 Nano Technologies

Nano technology fabrics (also called engineered fabrics) are made by adding to the fabric small particles that will make it reach new properties. These properties can be for instance a super high resistance to water (also called super-hydrophobicity); more strength and elasticity; moisture free and odour elimination... Moreover, this technology is also developed to revolutionized industries such as drug delivery, medicine or tissue engineering (Wikipedia 2016).

Optical fibres and Nano-technological fabric are part of what Youngjoo and Dong (2013) called: “key solutions for the generation’s happiness, identity, value, self-realization, health and role”, focusing on long-term development and future generations.

3.8 *Two Kind of Markets*

After treating the different components of the sustainable luxury fashion and fabrics industries as well as how it is influenced. The chapter will now have a practical approach; taking as example two different markets: the American and Ethiopian one. These markets are especially interesting because they are representing a mature and a developing market. The different impacts of the sustainable fashion and fabrics

industries on these different markets will be found below. The point is that sustainability in these sectors offers opportunities for all kinds of market and these two countries are a good example for the extremes.

3.8.1 United States Sustainable Fashion and Fabrics Industry

The American apparel and fabrics industries represent \$70 billion annually, employing 500,000, exporting \$24 billion (in 2014); this is significantly contributing to the nation economy (TextileWorld.com 2016).

Aquisdata (2016), displayed the American industry results for 2015's second quarter with a net income of \$6.5 million that is \$2.9 million less than the previous quarter. However, the second quarter of 2016 showed a net income of \$9 million. All of these results are proving one thing; the "operating performance" of the American apparel and fashion industries has been touched by the real Brazilian Real devaluation (Aquisdata 2016).

Aquisdata (2016) also showed that the US fabrics industry is a huge employer, accounting for 2% of the whole US manufacturing force. Americans textile firms are globally competitive on the market even looking at the raw materials (as seen in part 4.5 US apparel firms are trying to source on their own market to save transportation costs). The main strength is the cotton thanks to the historic American cotton farmers.

Looking at the innovation, the American market is also important, investing total of \$1.6 in 2013. In that reason, the American textile industry is highly skilled and technologically advanced (Aquisdata 2016). Recent years shown that technologies have been invested in niche markets, more effective work processes, retooling businesses and controlling costs.

Globally speaking the American textile industry is ranked number four, behind China, India and Germany (Aquisdata 2016). It is important to understand is that cost reduction has been so effective in the American textile industry that they can export their products, opening to new markets and source of income.

Concerning sustainability, non-woven products are classified as durable, disposable textiles. US and thanks to its own technology the US market is making this kind of product. The objective is to make it lighter, more efficient and cost effective as well as ethically clean. This kind of textile is used a lot by the automobile industry, which is still huge in America. It also represents "the most valuable market for industrial textiles". Moreover, protective apparel is emerging in smart fabrics and North America accounts half of its total regional market, taking the lead (Aquisdata 2016).

Additionally, the US has just strengthened their collaboration with the textile exchange Organic trade association. This second move is clearly defining a shift in the mature American fashion and textile industries (Aquisdata 2016). The US market is opening to the international using the trend of sustainable clothes. US textile and fabrics industries strongly believe that sustainability and innovation are the keys to face market maturity, saturation.

Finally, the Trans Pacific Partnership endorsed by the US textile manufacturers (20/01/2016) is arguing once again in favour of the national and industrial new taste for sustainable products. This partnership aims at ruling the yarn origin; providing “multi year tariff” for sensitive products and new terms to provide stability to western fabrics & fashion production cycle (Aquisdata 2016).

3.8.2 Ethiopian Emerging Sustainable Fashion and Fabrics Market

The Ethiopian sustainable fabrics and fashion industries are very much different comparing to the American market. The Ethiopian overall fashion and fabrics industry is at the image of its country; it is emerging. This standpoint is very interesting because sustainability and developing economies are not often linked to each other with growth. In fact, developing countries often see sustainability as a weight reducing their growth rate. In that reason, during international meeting developed countries will display important sustainable concerns toward developing countries; asking them to act more ethically. Developing countries too often defend themselves explaining that while developing, developed countries didn't worried about environmental concerns.

However, sustainability is becoming such an important issue that it concerns each country. Indeed, more and more countries are changing their behaviour to become more environmental friendly. Sustainability is a matter taking into account every ones' action; not feeling concern about it is some kind of a reckless attitude.

Ganguli Rupa in the just-style green report (2014) is quoting Mr. Berhanu Kebede (an Ethiopian Ambassador to in the UK). B. Kebede is explaining that the Ethiopian government is making tremendous efforts in the textile and fashion industry in order to act more sustainably and ethically. These various efforts have been and are being made focusing on giving an impulse to the textile Ethiopian market. The main point is to finally reach a full use of the Ethiopian potential in regarding the textile industry. In other words, the government is committing into the textile industry; incentives have been created to attract FDI and had brought «famous textile brands to Ethiopia».

Moreover, in his quote B. Kebede is giving examples such as the cotton market in Ethiopia. The Ethiopian government is even getting involved into sub sectors such as the cotton market. This help is made through a privatization of state owned factories that will be much more competitive and developed while being partially privatize. Ethiopia is bringing FDI to promote and fully exploit his fashion and textile industry (called «GTP, Growth and Transformation Plan»).

Ganguli (2014), explains that the luxury and fashion industries have already started to work with the Ethiopian textiles industry; using traditional skills and handloom fabrics. These products have a certain reputation as they have been seen in «fashion show cases in Europe, US and within Africa». Well-known brands even started to develop «mainstream collections» using Ethiopian cotton and weaving techniques.

This recent trend is also supported by Mr. Fassile Tadesse the ETGAMA's president (Ethiopian Textile and Garment Manufacturers Association). He explains that the recent years' presence of Ethiopian products on worldwide showcases have partic-

ipated into developing the interest on “made in Ethiopia” goods. This recent interest from Europe and the US is not just about buying as they also want to get a deeper understanding of what is the Ethiopian knowledge; where does it come from. That is why, buyers from overseas come to Ethiopia and visit the Ethiopian textile suppliers.

Ganguli (2014), is writing that the reason why these big US and European buyers are getting more and more involve into the Ethiopian market is because they found something that is nowhere else. The Ethiopian cotton and textile is an added value to these firm’s value chain. These Ethiopian techniques and skills of production allow the firms to produce better quality at affordable price (on a durable basis). Ethiopian government incentives for FDI are one of the drivers but it only speeds up the process. The global increasing concern for sustainability, ethic and environmental friendly goods is also supporting the Ethiopian fashion and fabrics industries. In other words, the Ethiopian textile market increase is a combining result of government incentives, market trends and historical weaving skills.

In Africa events such as «Origin Africa» have been created in order to promote and show what African designers are capable of. The final aim of this event is to show that Africa and especially certain countries are chosen destinations for sourcing and doing business with the textile industry. In a few words, this kind of event is advertising on the African textile industry capacity. Looking at Ethiopia, it has been present from the very first showcase on the event. Ethiopia become even more visible internationally when an Ethiopian (Addis Ababa) won the first prize (Ganguli 2014).

The major advance of such event is for local fashion designers. Sourcing is already known internationally and works well. However, Ethiopian designers are known regionally but find trouble into getting known overseas (Ganguli 2014).

3.9 Is Sustainability the Option for the Future of Luxury Fashion and Fabrics Industries?

So (2013) strongly believes that “Using more sustainable alternatives to traditional fibres is critical for clothing and textile brands wanting to reduce their environmental footprint”. Within the Just-style green-report, it is clearly explain that sustainability in the luxury fashion and fabrics industries are not just trends, something consumer are gaining awareness about or something being developed by governments. Sustainability is required for one of the most polluting industry on a sick planet earth.

Moreover, sustainability is the only option that looks viable for these mature industries. In the whole fashion market, for example, participants are searching for new inputs, new sales possibilities. Thus, sustainability opens new markets on a durable option; in both developed and developing countries.

To be viable on a long-term vision and a large scale; sustainability has to be more efficient. In order to be improved, sustainability has to be developed thanks to technologies. Science and innovation are the future of the fabrics industry that is directly impacting the fashion industry.

So (2013) explained that even looking at sourcing, market and industry will always benefit from supply diversification. K. So argues even further explaining that the fabric and fashion industry “can take heart from continued innovation amongst fibre and fabric producers into new material source”. Technological innovation results into new products that have improved, additional use. In that reason, the innovations are a source of need creation; a key for the potential market future growth.

Innovation can also be found in the processes or the use of new materials for production. Jay Nalbach (chief marketing officer of innovative flax developer Crailar) explains that one of the big sustainable fabric concern is the cotton production. Compare to cotton flax uses 99% less water (from production to processing). Additionally, to costs saving, the sustainable pressure is something that makes the company looking for change and use new materials such as using Flax instead of cotton.

Youngjoo and Dong (2013) looked at the future direction of the textile and fashion industries. They succeeded to reach a deeper comprehension of those industries by dividing it into segments and consuming behaviours. The authors are looking at the whole product life cycle to access it.

Firstly, ladies apparel segment is very hard for sustainable products to penetrate because it is focusing on design and style. Sustainable apparel still has some bad perception among consumers’ mind. However, the words environmental friendly or eco-friendly are better argument to sell goods and have an improved fashion factor than “sustainability” Youngjoo and Dong (2013).

Then, looking at the items transformation; an item can be disassembling for each component to be pulled apart and reuse. For example, wool can be taken out and reuse to make other clothes. They can also be re-weave if the fibres are not damaged.

Sportswear such as outdoor wear or golf wear are very must demanded to be recycled. They are many reasons causing this high demand. Firstly, fibres from performance sport clothes are very easy to recycle. Secondly, because of its performance of smart textile, customers are looking for cheap product like these. Finally, simply because their functionalities are broader; you can recycle into a bigger range of goods.

Youngjoo and Dong (2013), discuss that certified organic and green materials should be used as a universal truth on manufacturing sustainable products. This final green certification would make things much more transparent and inspire trust from consumers. The authors concern go even further, explaining that firms should allocate money not to developing sustainable strategy or green marketing and instead put their money into sustainability itself, on the entire product life cycle.

Taking into account a similar philosophy, Goworek (2011) also agreed on the importance of sustainability within the luxury fashion and fabrics industries, believing that “significant growth” is to come in the ethical fashion industry. Taking as an example that it is currently increasing by about 40% (according to the product number), Helen Goworek is very optimistic even while looking at the cotton market.

The UK-based Ethical Fashion forum agrees saying that “It’s just good business, good long-term business to adopt these sustainable approaches, whether that’s a more efficient factory or creating fibres that are more sustainable and perform better. It just makes business sense.”

4 Recycling and Sustainable Limits in the Fashion and Fabrics Industry

Sustainability in the fashion industry is defined by a durable, ethical, long-term way of producing and doing business. Sustainability includes the idea that making business can go along with a firm's activity on its ecological environment. Firm uses recycling as the major component of sustainability.

The whole recycling process can be seen thanks to three different type of actions: “*reduce, reuse and recycle*” (WWF website 2016). Companies from the fashion and fabrics industry can **reduce** their waste; adopting new fabrication processes that have a more efficient use of material. Firms can even look at reducing their waste first by considering the waste not as such but by using it for another purpose. However, this model has its limits. Companies cannot endlessly reduce their waste reaching zero waste production; it is just impossible.

As introduced above; there are a lot of resources that companies can **reuse** to reduce their environmental impact. Reuse can also be applied to the customers; sustainability is a matter of everyone. In other words, consumers can take their unwanted clothes to charity in order for them to have a second life. Apparels are too often seen as disposable product not made to last. Unfortunately, product or resources cannot be reused indefinitely. At some point, they will be no more resources but only waste.

Recycle is the quintessence of recycling. Recycle is the principle of taking a final product and change it in order to have another use of it. It is the principle of restarting the product life cycle thanks to some kind of transformation. Recycle has its limit; sometimes the transformation process takes more resources than simply produce one from raw product. Moreover, recycling can be done on final products; but is it possible to recycle recycled goods? How many times can we recycle?

Taking the famous example of apparels made from plastic bottle and glass disposal. First the transformational process costs an important but still sustainable environmental impact. But more importantly, the final apparels once recycled cannot be recycled anymore. Their chemical aspect is so complex that no recycling transformation is possible.

According to So (2013), the recycling process is not necessarily synonym of no or very low environmental impact. The recycling process uses procedures that can include fertilisers, insecticides, pesticides and polluting chemical (that pollutes a lot to be produced; the best example is petrochemical).

A solution to recycling processes that pollutes a lot can be the “loop fibre”; these fibres can be broken down into their original aspect and reused for production. This material gives an endless perspective of recycling; creating new fabric from old garments, products.

Finally, while speaking about recycling used products from consumer, the process requires some organization to gather used goods and distribute it to recycling factories. This mission is commonly insured by municipalities. Kaye (2011) explains in The Guardian that only few municipalities accept textiles into their recycling pro-

grammes. The reason of this is because clothes are not easily recyclable. Moreover, municipalities feel that people are not really looking enough to buy recycle clothes, thus there is no market. Indeed, people are used to simply put used clothes into the dumpster and not to try recycling it.

5 Innovative and Sustainable Examples

Innovation has always been a key driving force of the economy. As J. Schumpeter and Say explained, innovation in the economy is a source of value creation, temporary monopoly and creates demand (Investopedia 2016a, b). It is temporary because others come to compete imitating your innovation and enter your market. However, innovation allows a firm to gain a certain hegemony on a market created and developed by this company. Moreover, innovation on a sustainable point of view will permit to combine on a virtuous circle the profitable and ethical aspect of making business.

In these sub-headings below, a list and explanation of sustainable innovation that will shape the future of the fabrics and fashion industries is exhibited.

5.1 Brands, Firms and Designer's Involvement

Dying with Air

Breyer (2012), explain that Colorep a Californian firm has developed a new process in order to dye fabric. This method uses the air to dye garment; thus, it is saving tons of water. The process uses colour that is transferred from paper to fabric in one single step thanks to heat. Figures showed that for a pound of fabric this innovation is saving up to 75 gallons of water; uses less energy and have no harmful results for the ecological environment. This method has been principally used by Costello Tagiapietra and Gretchen Jones.

Digital Printing

Digital printing is the fact of directly applying the printing to the fabrics; using modern printer and considerably reducing the water consumption. This technic allows a certain firm to precisely reduce water usage by 75% and minimize textile waste (thanks to a more efficient technique). A technic used by designers such as Alexander McQueen and Basso & Brooke (Breyer 2012).

Online Shopping Tools

This might look meaningless but in fact it is very important. All the guidelines and other kind of sizing tools on Internet are very efficient. It permits firm to lose less

and less product from returned products that cannot be sold back. This kind of tool is reducing an apparels' distributor waste, increasing its selling efficiency.

Water Free Stone Wash

The jeans' firm Levi's has created a new way to stone wash its jeans. This new method allows the brand to use 28% less water than a standard stone wash. At the end of the jeans production this new washing system makes Levi's spend 96% less water (Breyer 2012).

Smart Tailoring

The smart tailoring technology is also called DPOL (Direct Panel On Loom); it was created by Siddhartha Upadhyaya, an Indian designer. The purpose of this innovation was to increase fabric efficiency by 15% and lead-time by 50%; it shows its efficiency. The technic consists into attaching a computer to the loom that will analyse all the data and will do weaving, fabric cutting, and patterning happen all at once. DPOL is at the same time an immense cost saving and an ethical way to produce; saving water and waste up to 80% (Breyer 2012).

Retailer's Issue

Fashion retailers always have had big waste of textile because of unwanted textiles. In that reason, more and more retailers are moving towards closed loop system. For instance, brands such as Patagonia allows its customers to drop off unwanted clothes in store or even post it to its Nevada service centre (Kaye 2011).

BASF Textile Marketplace

M2 Presswire (2014), explains that BASF Textile Marketplace is something created in order "to support sustainable development of the China Textile industry". The idea is to have close relationships with the partners. BASF want to commit into sustainability within Chinese company. Thus, it provides Chinese textile firms to personalised their offers; giving them sustainable solutions. BASF philosophy is "We create chemistry that makes fashion love sustainability".

Biotechnologies

PR Newswire (2006) displays that Haute Couture designers started to use biotechnologies. For example, they used biodegradable fabrics made from corn sugar (such as Halston, Oscar de la Renta, Stephen Burrows, Heatherette, and Elisa Jimenez). This technological advance is driven by a World Congress on Industrial Biotechnology work, they can now check how their innovation is influencing the fashion industry. Biodegradable fabric is a very important innovation as it solves all waste ethical problems created by the fashion and fabrics industries.

Puzzle Apparel Company

Business News website (2013), explains the incredible story of Trowbridge that went all over the world and now created a company based on a principle of sustainable fashion. Thanks to her website, shoppers can “puzzle” their own apparel, designing it thanks to the website possibilities; choosing patterns and fabrics. After what, the American artists from Maine State will hand make the bespoke orders.

5.2 Product Innovations

Vegetal Fabric

High tech sector is getting more and more involved into fashion as technologies are playing an important role for the sustainable fashion industry. In this case, the result is a fabric made from tea, coffee beans and/or milk. There are different examples of those kind of fabrics. The first one is a German student (Anke Domaske) that succeeds to create fabric out of “Eco milk fibre”. Others like the company Virus made fabric from recycled coffee beans. This fabric is not only a fully sustainable innovation. However, it has a high performance against cold weather and is much eco-friendlier (Breyer 2012).

Plastic Bags and Beer Bottles Fabric

This example of products recycling in order to create a new fabric might be the most acknowledge one. It is the fact of taking plastic bags and beer bottles and recycle them by splitting the synthetic particles a part. Once the chemical structure has exploded, chemist can then melt it and takes the fibres; creating a certain fabric. This has for example been used in the “I Am Not A Virgin” jeans; made from 25% of bottles fibres and the rest of cotton (Breyer 2012).

Hand-Dying

This is the perfect example that proves that sometimes the oldest technics are the best and development doesn't bring just advances. In fact, dying a garment by hands allows the process to use much less additives but much more labours. Few designers use it because of its rarity; Renee Mennen and Stefanie van Keijsteren are an example of these users (Breyer 2012).

Bio-filtering Wastewater

Also, known as Sequencing Batch Bio filter Granular Reactor; this technology is a process that is aiming at removing toxic components from dying. This uncommon method uses microorganisms to treat fabrics. “The wastewater is poured over the microorganisms, which process pollutants, and each aggregate holds up to 10 times more microorganisms than traditional technologies, and produces 80% less sludge than conventional biological filters” (Breyer 2012).

Waterproof Outwear

Brunello Cucinelli presented in Milan a waterproof outwear collection. He surprises the editors when explaining that the used fabric was camel hair and not wool. New sources of raw material made others become more durable (Ray Smith 2016).

Super-Hydrophobic Textiles

Engineering on hydrophobic textile gain significant advances those years. These advances led to scientific discussion and business understanding of the innovation. Indeed, an application on outdoor and protective textiles is being created. To be more precise “the challenges in application of super-hydrophobic textiles to clothing materials in terms of comfort properties and durability are discussed with the suggestion of further research opportunities to expand the application” (TextileWorld.com 2016).

6 Conclusion

The Korean fashion and textile industries must be set as an example for the global market. In Korea these two sectors are deeply involved into sustainability because the market have reached another comprehension of sustainability. Other countries have to understand that what forces Korea to move toward sustainability is not the government regulation but the shareholders’ interests into CSR (Youngjoo and Dong 2013).

Sustainability in the luxury fashion and fabrics industries is a matter that concerns consumers, retailers, buyers, suppliers, manufacturers and farmers. Sustainable apparels have to reach a high level of transparency in order for each stakeholder (included in this process) to have all the required information. Thus, ethical, environmental friendly, eco-friendly products should reach sustainability through each and every of the product life cycle.

According to the current ecological situation, it is understandable that governments finally starts to take actions in order to become a driving force towards more “green clothes”; which represent a long-term solution for these sectors’ future growth. Governments can create economic incentives, organizations and change the legislation to become a driver.

The sustainable apparel market is also driven by an arriving consuming force: The Generation Y (young generation). This segment represents the markets’ future in terms of potential income and cash flow. Even if this generation is willing to commit to a sustainable consumption; the communication as not been effective and the generation has few knowledge on the subject. That is why educating marketing is the key. A requirement, thus, would be a transparent communication of the brands, so that the customers learn what they are actually buying.

This chapter also showed that consumers and manufacturers can be issued from a mature or emerging type of market: sustainability is a global increasing market that

involves opportunities for both markets. One wants to aim at new targets and widen its market; the other is looking for a dynamic and accessible market. Both can work together has seen with Ethiopia that exported its traditional and sustainable goods to the US for instance (developing their sustainable market).

However, Sustainability (and for instance recycling) has some limits; but before reaching these limits the market has still tremendous efforts to apply.

Sustainability is something that is proven as being profitable; allowing costs saving thanks to new technologies such as: Nano-fabrics, Optical fabrics, ecological fabrics... It is driven by innovation first, then consumers' growing demand and awareness, global ecological issues and government regulations.

Wherever is your standpoint; you can gain from sustainability.

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The Sustainable Model: Designing Within a Sustainable Framework

Sanah Sharma

Abstract Sustainability within the fashion industry is a matter of growing concern with the emergence and surge of the fast fashion system. The research literature is aimed at defining the current fashion scenario, understanding the roles of stakeholders involved and presenting significant existing models of sustainable design. This chapter proposes the need for a practical strategy towards a sustainable future by setting short-term and long-term goals. Education as a solution that penetrates into the layers of institutes, collaborative design, and brands is discussed along with the notion of developing better consumer relationships through emotional and conceptual strategies for value addition. This chapter touches upon recognizing topology as an exploitable concept for innovative sustainable design. Re-evaluation of the design process is explored through the development of a hybrid cutting technique called Planar Flux, inspired by the Mobius strip, that urges one to view patterns axially while reducing fabric consumption, cutting and construction simultaneously. The success of the technique is assessed using parameters of collaboration, development of zero-waste pattern and positing its application in a fast fashion business setup. The aims are to corroborate the benefits of such a system, its influence on the consumer and contribution to all aspects of sustainability.

Keywords Sustainable · Fashion · Pattern cutting · Collaboration · Education
Fast fashion

1 Introduction to the Fashion System

The fashion industry is among the largest and rapid growing industries of the world. With its arms extending into films, photography, music and pop-culture, fashion wears a spectacle of glamor. The inevitably transient nature of fashion has led to the growth of unsustainable practices, at both pre and post-consumer stages. Awareness

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of environmental concerns and social impacts of the fashion industry has steadily increased during the last decade. This has in turn led to a gradual response by the fashion industry to improve the environmental and social impacts of the manufacturing process (Kozlowski et al. 2015).

Benefits that accompany improvements to the sustainability of apparel products are subject to restrictions by the production system, the business models that market and sell apparel products, and the behaviors of consumers who purchase these apparel products (Kozlowski et al. 2015). Hence, it is imperative for the design process to constantly evolve with changing times. Creating designs/products while keeping in mind the relationship between the consumers and producers are a vital aspect of the design process. “While the aim of sustainability in fashion may be rather clear, the methods of reaching sustainability are not clear at all. Sustainable fashion is a complex effort, including a lot of idealism, but its many elements have to be taken into consideration on a practical level” (Aakko and Sivonen-Koskenurmi 2013).

Fast fashion has encouraged a system of rapid production and disposal that “directly and indirectly leads to the dissemination of similar styles globally, a process that leads to its ever-faster fashion ‘death’” (McQuillan et al. 2013). Rapid consumerism has led to erratic buying patterns. To expect a sudden change and the adoption of slow fashion strategies seems idealistic and farfetched. While slow fashion can be considered a long-term goal, the current scenario demands an immediate solution that can provide sustainability at the design stage for large scale production.

Designers, manufacturers, consumers, educators and students are all stakeholders in this endeavor. A sustainable model is one where all stakeholders interact and participate towards a better, greener future for all. While their roles may be predefined, they are each interdependent on the other and it is therefore of great importance for the stakeholders/actors to realize that the current issue of unsustainability is a consequence of their collective actions. Hence, they must work together collectively to provide solutions in their own domains. The definitions of sustainability are varied and could be interpreted by each stakeholder in a different manner. It is essential to lay out a core generic concept of sustainability to provide a well-defined protocol.

In this chapter, redefining the role of the designer as a problem solver is considered fundamental to realize the goal of sustainable development in fashion. Nearly 60–80% of lifecycle impacts of a product are determined in the design stage (Nerurkar 2016). This hints at the need for a more integrated design process. The much celebrated fashion industry places the designer high up on a pedestal, labelled with the status of being a creative genius. In reality, the designer is often detached from the actual making process and as Robert states “often the hand that touches it [garment] the least is the hand of the fashion designer” (McQuillan et al. 2013; Romano 2011). The disparity between the designer and the maker has precipitously widened with the surge in fast fashion. Bridging this gap requires a highly thoughtful integrated system of design and manufacturing. The current chapter will discuss with examples the developments by designers that are prevalent in the existing scenario. Subsequently, it will also explore the innovation of a hybrid cutting technique, Planar Flux that meets the criteria of the proposed sustainable strategies for both immediate and long-term solutions.

This chapter also advocates that to evolve the fashion system and create visible legitimate change it is imperative to make modifications to the education model. It is also equally essential to view education from a different perspective altogether. Education in the current chapter is regarded as the transfer of knowledge, skill, ideas, agreements and disagreements. It is posited that education can be branched into different areas that are not just confined to the conventional boundaries of formal tutoring. In addition to regarding education as a key solution, the use of topology in fashion practice is also deemed a viable solution that has been and further can be explored by designers to meet the proposed paradigms for a sustainable outcome.

2 Defining Sustainability

Sustainable fashion can mean different things to different people. The designer, the manufacturer, the consumer, each have their own interpretations. To the designer sustainability may refer to the creation of design that does not have a negative impact on the environment; to the manufacturer it may be the need for ethical trade practices, fair wages, etc.; to the consumer it could mean recycling or upcycling the product.

Sustainability is defined as ‘the capacity to endure’. According to the Burntland Report sustainable development can be defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Aakko and Sivonen-Koskennurmi 2013). Though sustainable fashion has several definitions but as a concept it is three-fold—the human aspect, the environmental aspect and the business or commercial aspect. An ideal sustainable model is one that addresses all the three aspects. Upon asking Prof. Julian Roberts, founder of Subtraction Cutting and MA Tutor for Mixed Media Textiles at the Royal College of Art in London UK, what his opinion on an ideal sustainable design was:

A well design artefact which is needed by a known audience or customer/individual, rather than randomly thrown out into the world in the hope that someone wants it.

It needs to be thoughtful in it’s design, well constructed and made, fit for purpose, kind to the body and comfortable, and aesthetically desirable to look at and wear.

If made in larger production runs then it needs to be sensitively graded across a sizing scale which properly acknowledges different body types, rather than simply being enlarged or reduced in scale.

The makers need to be respected, and paid well for their craft, rather than profit disproportionately put into its marketing or management.

The story of its development and manufacture ought to be part of its unique selling point, and all involved in making it properly acknowledged for their involvement and collaboration.

There are too many garments made for no reason, which nobody need.

Dr. Rickard Lindqvist, a tutor and researcher at the University of Borås says “I do not know if there is such a thing as an ideal sustainable design as there is so many parameter[s] to consider. I guess the most sustainable design are to design things that lasts for a long time i.e. long term low consumption of rec[s]ources.” He also believes

that different cultures could have different perceptions of sustainable fashion. To him, sustainable fashion simply means “caring about the world and other humans.”

For luxury designers like Vivienne Westwood and Stella McCartney sustainability is an integral responsibility of designers. Westwood claims:

There is a real connection between culture and climate change. We all have a part to play and if you engage with life, you will get a new set of values. Get off the consumer treadmill and start to think and it is these great thinkers who will rescue the planet (Joy et al. 2012; Ecouterre 2012). To Stella McCartney eco-fashion is a lifestyle choice. She says:

“You have to create demand so the consumer base will grow. We’ve been doing organic for years in my own collection, in my lingerie and with the Adidas collaboration. We touch on it across the board. I think it’s a bit more sincere to do that. It’s a part and parcel for us as a brand” (Joy et al. 2012; NBC New York 2011).

Over the past decade the fashion industry has become ‘unsustainable’ with the growth of fast fashion where an absurd circle of micro trends (Firth 2015) has created greater desire for purchase. While fast fashion has generated greater profits it has also made fashion desperately behind in sustainability (Aakko and Sivonen-Koskenurmi 2013). Today’s consumer is completely absorbed in fast fashion. If fashion has to get truly sustainable, it has to make its way into the consumer’s wardrobe and for that it has to be commercially at par with the fast fashion trends at a large scale.

3 Growing Concerns Regarding Sustainability Within the Fashion Industry

The post-industrial environment has led to the emergence of a self-centered, consumer throwaway society (Oshry 2012). About 20% of the human population is using more than 80% of resources available (Wilk 2017), in a cycle of exploitation of each other, the planet and the millions working in unethical conditions. One of the major concerns is that the rest of the 80% population yearns to join this 20% which in the case would ultimately lead to great ecological catastrophe (ibid).

Fashion is an estimated \$3 trillion worth industry which is also why its negative outcomes have a very large-scale impact. Nearly 30 kg of textile waste is generated per person yearly in the UK alone (McQuillan 2012) and as developing countries will improve their economy, they too will create more textile waste in the years to come (Aakko and Sivonen-Koskenurmi 2013). All this textile waste accumulates in landfills that take up space and cause air, water and soil pollution while also contaminating the atmosphere by discharging carbon dioxide and methane (Brown 2013). The Organization for Economic Cooperation and Development (OECD) estimated that by 2020 there would be 45% surge in waste generation than we had in 1995. Therefore, waste prevention is becoming a key aspect of eco-design (Brown 2013).

This indicates the need for design and production to be more integrated. Rissanen (2005) insists on the need to consider fabric as a precious resource that must be utilized wisely to reduce wastage at the design and production stage unlike the typical

emphasis given majorly to post-consumer waste of clothing. The conventional production methods utilize a marker, cutter and patternmaker where the marker-maker works within the parameters set by the patternmaker, and indirectly the designer (Rissanen 2005). Therefore, the responsibility of maximizing fabric efficiency essentially lies with the designer who in most cases is apathetic about fabric usage.

While most designers are aware of the growing need for sustainable design, they are unclear of the methods to achieve such a model. In a quest to provide some solution they often turn to so-called sustainable raw materials. However, the mere use of these eco-friendly labelled fibers is no solution to the larger issue at hand as each fiber has its problems (resources, disposal, recyclable?) (Rissanen 2005). As of today, there is no true perfect selection of sustainable materials available at the moment (Aakko and Sivonen-Koskenurmi 2013). While there may not be any ideal fibers it could be helpful contributor to sustainable fashion if the designer chooses a relatively less polluting fiber to reduce the environmental footprint. Rissanen (2005) states that while recycling is often considered sustainable, it is also known to have negative impacts on the environment through transportation (fuel emissions) and reprocessing (water, energy, chemical consumption). Therefore, it is more advisable to reduce than to recycle.

4 Consumer Connect/Disconnect

Globalization and decentralization of fashion (i.e. mass production) empowered the consumer and thus was born the era of consumerism. With no responsibility and accountability among designers, producers and users, the business of fashion has become highly unsustainable. The concept of need has been twisted into a form of entertainment. George Bataille said that waste and destruction were the ultimate products of capital consumerism (Wilk). Today's consumer culture can be viewed as a form of mental illness that is characteristic of inequality, instability and growth, all of which overrides the human priorities of education, health and quality of life (ibid). A re-evaluation of human culture and environment by understanding the relationship between environment attitudes and behavior is essential to bring about real change. Take the example of Japan where worshipping nature is an integral part of their religion however they have indulged in widespread destruction and obliteration of landscape and ocean (ibid). Sustainability is still perceived as a trend rather than a way of thinking. This is one of the key reasons for a disconnect between users and designers.

Julian Roberts's sums consumer behavior as follows:

Consumers buy what they are given, and most aren't aware how the garment is made, because they are not marketed with the story of their development.

The perception of Sustainable Fashion has grown, and there is consumer interest in it, but it needs to be a standard that all design students learn to make sustainable design for every single project, rather than it be taught as a quirk.

An important factor to be considered while assessing consumer behavior is self-concept or self-image. A person's actual self-concept (how the person views himself/herself) differs from his/her ideal self-concept (how the person thinks others see him/her) and from his/her others self-concept (how the person thinks others see him/her). The consumer makes a purchase decision based on which 'self' he/she is trying to satisfy. Goods used by consumers are therefore seen as useful tools to define consumer identities and their social status. Over a period of time their buying patterns could change to accommodate new aspects of their 'selves' (Nerurkar 2016). Most consumers aspire to project a higher social status through their choice of fashion. Earlier, the gap between consumer reality and aspirations was apparent as luxury fashion remained exclusive and out of reach of the masses. Fast fashion has blurred the lines that divided and maintained this gap. They provide high fashion looks at cheap prices that instantly attract the consumer. Clothes are promoted, sold and bought simply on the basis of appearance and not quality, feel and worth. Consumers are cleverly coaxed into buying such imitations of catwalk garments that emphasize on the "look" and consequently discourage lasting relationships between the user and product.

Fashion has become more of a style variation today as fast fashion has made design innovation a challenging task. Such a system has slowly made fashion very generic. Today one could walk into 10 different stores and find the same looking pieces with slight or no variation in color, style lines, fabric, etc. The surge in sales of fast fashion brands is not attributed to design innovation but rather to its micro trend cycles and price points that excite the consumer. The question is for how long can this model of business keep the consumer interested? At some point the consumer will come to realize that every second person on the street is sporting the same look as theirs more or less. This will ultimately result in a reflection of buying choices and habits which will then lead to the appreciation of innovative design that is new, unseen and unique enough to excite the consumer again provided it is available at affordable prices. A model of design creation rather than design adaptation is refreshing for both consumer and designer.

It is vital to an innovative sustainable design based business model to assess the reason for consumer disconnect between what is sustainable and what is fashionable. Eco-friendly fashion is often more expensive but hardly 'fashionable'. Consumer awareness though on the rise, is still a very small number to produce any drastic impacts. According to the insights provided by Cotton Incorporated (2013), 61% consumers are less likely to pay more for eco-friendly clothing due to the current economic situation. Sustainability is still not a primary purchase driver for consumers. Therefore, sustainability has to be fashion-savvy and budget-friendly to translate into a successful business model. There also must exist a transparent communication between the designer, producer and user to achieve sustainability at all stages of a product's lifecycle.

5 Fast Fashion

Fast fashion refers to the fast paced trend cycles that provide low-cost alternatives of luxury fashion trends to the consumer (Joy et al. 2012). The very nature of such a model encourages disposability. The supply side of fast fashion ensures scarcity, which in turn drives demand (Joy et al. 2012). It takes as little as 2–3 weeks from the design room to the retail floor for fast fashion companies like Zara with the realization that new fashion trends had to be on the sales floor in a timely manner before the consumer’s attention moved to the next thing (McQuillan 2012; Forbes 2015).

John Thornbeck, chairman of Chainge Capital mentioned that fast fashion may be the most important disrupter in the retail industry today (Forbes 2015) but these disruptive innovations, or product services, that transform an existing market by introducing simplicity, convenience, accessibility and affordability, have the most positive impact on a company (Forbes 2015). Elizabeth Cline, a New York-based journalist and author of “Overdressed: The Shockingly High Cost of Cheap Fashion” said that younger people are getting more engaged and asking questions about where and how clothes are made but fast fashion is hard to resist (Milnes 2015). The current scenario sees a ‘whole generation of consumers who know nothing more than low prices and trendy of-the-minute clothing’ as said by Cline (Milnes 2015). Fast fashion firms earn high profit margins (about 16% on an average) compared to their traditional retail counterparts (only an average 7%) thereby making fast fashion a lucrative business model (Joy et al. 2012). There are fewer markdowns at Zara as the product arrives ‘just in time’ with a speed that creates demand and assures quick turnover (Forbes 2015). The styles are not replenished but rather replaced with new looks thereby urging the consumer to make a purchase as soon as they like the product as they will not see it again. This means soaring profits due to lower markdowns which eventually results in strong gross margins for the company.

Since fast fashion has proved to be a commercial success, most companies would refrain from risk-taking design as it may not be economically promising to invest time and money into the development of a design if the likely outcome is unknown (McQuillan et al. 2013). These companies direct their focus on creating aesthetic copies of high fashion rather than replicating their technique or process developments. McQuillan states:

The goal is to generate a facsimile of the original that only withstands shallow consumer inspection, and to provide it at a lower price point. (McQuillan et al. 2013)

Such a model promotes a sense of ‘superficial novelty’ that provides access to fashion to a larger target audience (ibid).

Fast fashion companies are able to sell their products at low price points primarily because of three factors—cheap fabrics, cheap labor and poor manufacturing/processes. It is absolutely certain that such products would fail to stand the test of time. Typically products from fast fashion brands don’t sustain more than ten washes. However, consumers seldom experience any regret in purchase or disposal of these clothes (Joy et al. 2012).

While successful in terms of business, this approach has in-turn become the second largest contributor to environmental distress (Milnes 2015). People prefer buying new clothes than repairing older ones since purchasing has become cheaper than repairing (Rissanen 2005) thereby disposing and adding more textile to landfills. The other major setback is the lack of creative innovation by the designer. Fast fashion approach doesn't directly invest in design but rather takes inspiration from successful and promising trends seen on the runways (McQuillan 2012). The designer's job becomes very monotonous and could have a regressive effect by eventually breeding a generation of designers who would merely "regurgitate past styles with little or no risk" (McQuillan 2012). The major concern is that fast fashion lacks innovation, creative drive and most importantly it lacks responsibility—both social and environmental.

6 Making Fast Fashion Sustainable

Through the analyzation of the literature available and discussed in the previous segment, it is evident that sustainability in design will "open a plethora" of new opportunities to discover and exploit (Nerurkar 2016). The issue of fast fashion has blurred the lines between needs and wants of the consumer. To penetrate into the psychology of the consumer and shift their attitudes from erratic spontaneous buying to thoughtful purchasing is a pressing need. In order to seriously address the problem at hand, it is imperative that a conscious understanding of short-term and long-term goals be established.

There has been lot of conjecture associated with 'Slow Fashion'. Slow fashion is at large still a diffused concept that is still not very clearly defined. On the pretext of its name it seems to be an objection to fast fashion. According to Fletcher (2008), it is a different approach of various stakeholders/actors in the scene of fashion and not simply the opposite of fast fashion as there is no dualism (Aakko and Sivonen-Koskennurmi 2013). 'Slow' doesn't imply the temporality of fashion but signifies other factors well summarized by Clark (2008) as follows:

the valuing of local resources and distributed economies; transparent production systems with less intermediation between producer and consumer; and sustainable and sensorial products. (Aakko and Sivonen-Koskennurmi 2013)

According to O'Brien the slow movement is said to be initiated by a group of people "who insist on the irreducibility of time, and who call for the re-sacralisation of life, driven by the values of empathy and ecology against temporal rationalists who emphasize efficiency over sustainability in the name of promoting economic growth" (Kipöz 2013). Kipöz (2013) considers regarding slow fashion as:

an activist design practice which emphasizes endurance and ethics, takes strength from the philosophical project of deconstruction, in which the fashion system has transformed itself into a conceptual and radical channel from within the system.

Slow fashion is the philosophy of attentiveness. It is the process of mindful production, consumption and disposal. However, the success of slow fashion in the

mainstream sector has been marginal. Bonini and Oppenheim (2008) mention the five barriers to a greener future:

Lack of awareness, negative perceptions, distrust, high prices, and low availability. (Joy et al. 2012)

Joy et al. (2012) in their research found that while most consumers took their brands seriously (i.e. fast fashion and luxury brands), they did not have sustainable brands anywhere near their radar yet. An example of consumer obliviousness is the infamous case of when Nike that made news for running sweatshop operations. The participants in Hong Kong and Canada of the research carried out by Joy et al. (2012) did not change their attitude towards the brand; they didn't boycott the company's products (ibid). The Paris Ethical Fashion Show in 2007 showcased the talents of a wide range of designers from across 40 countries. The success of the show was plastered across media platforms. The fashion press reporting on the Spring/Summer 2008 collections during Paris Fashion Week that same month observed that many designers found their influences from nature. The press imprudently assigned the label of 'eco-aware' when factually none of the collections appeared to address any ethical or environmental issues (Gwilt 2009).

Looking at the larger picture of a sustainable fashion industry, it is suggested to set both short-term and long-term goals. While the short-term goals are created with the intent of bringing minor change and setting the foundations for a shift in consumer behavior, long-term goals would help settle the consumer in a new world of quality-conscious fashion that is durable and holistic. Figure 1 shows the difference in short and long-term goals. It indicates that the short-term goals may work within the framework of fast fashion so as to reach the targeted audience while in a small but significant way, 'slowly' shift the emphasis towards a more integrated process of making, selling and disposing fashion.

The fashion industry is no longer one that aims at providing basic clothing needs. Today, it is driven by the reins of desire; desire that is often induced by the very same fashion industry through movies, magazines, fashion shows, etc. This greed and desire has led to the emergence of a highly impatient and ignorant consumer market that is no longer restricted to the younger generation. The consumer wants aesthetic, trendy clothing. They are part of fast fashion and enjoy it. Therefore, fast fashion cannot be completely scrapped but rather we can make changes to the design process to make it more sustainable as an immediate solution which could in the long run help change buying patterns.

If fast fashion could be slightly slowed down and made sustainable, the impact it would have on the consumer and environment would be remarkable as the consumer would no longer feel guilty of buying and also feel a sense of contribution to reducing the environmental footprint, thereby enhancing the designer-consumer relationship. The typical design process usually follows a strict and rigid hierarchical pattern that sees the designer at the top, followed by the pattern maker, cutter and machinist (Rissanen 2005) as shown in Fig. 2. If this design process is sustainable and still capable of large-scale production then it can be deemed a successful model.

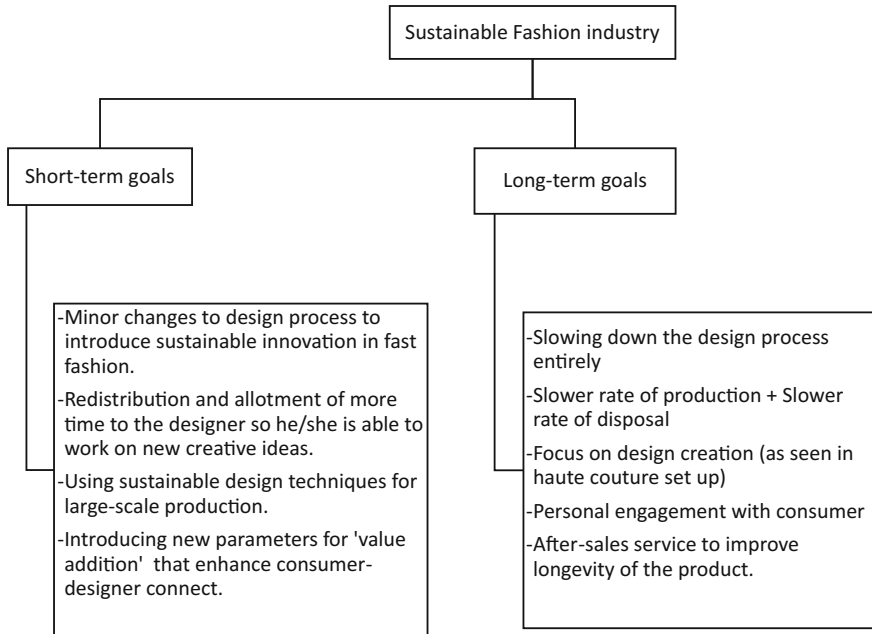
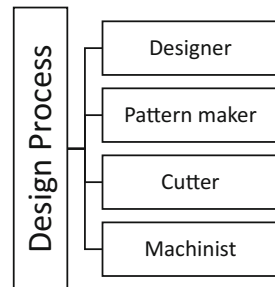


Fig. 1 Sustainable fashion: Short-term and long-term goals

Fig. 2 Design process hierarchy



- (1) 80% of a product’s environmental impact is determined at the design stage (McQuillan 2012; Thackara 2005). Rissanen (2005) suggests that instead of making a number of sketches relatively fast, the designer needs to incorporate pattern making into the design process of the garment.
- (2) Such an approach merges the roles of a designer and pattern maker. Julian Roberts’ Subtraction Cutting is an example of such an approach of designing through patterns.
- (3) This designed pattern must involve minimal cutting time and should ideally be a zero-waste design.
- (4) The pattern must also be designed to reduce sewing operations to maximize efficiency of the design process.

This study proposes that the design process must be aimed at reducing the time consumed to create the product, i.e. to reduce the 3 C's—Cutting, Consumption and Construction. Doing so has multiple advantages. By reducing the make-time,

- a. the workload on labor is considerably reduced, thereby addressing the social aspect of sustainability.
- b. the reduction of fabric consumption means lesser textile for the same amount of clothes produced, thereby addressing the environmental aspect of sustainability.
- c. the time saved can be redistributed and allotted for design innovation so that the designer explores different possibilities rather than simply imitating catwalk trends.

7 Existing Models of Sustainability

Rissanen (2005) broadly classifies garment making methods as traditional fashion creation namely Cut & Sew, Fully Fashioned and Jigsaw Puzzle, and those that are informed by environmental concerns like Cradle-to-Cradle and A-POC. While Cradle-to-Cradle relies on the philosophy of 'waste equals food', it has been observed that it is more beneficial to eliminate waste rather than managing it (Rissanen 2005). Rissanen's own methods of achieving zero-waste patterns utilize the Jigsaw Puzzle theory where the pattern pieces interlock each other thereby eliminating waste as well as the need for a marker (McQuillan 2012). Holly McQuillan, another fine example in the field of sustainable design, turns to fractals and hyperbolic topology to create zero-waste clothing. She reduces the size of the tessellated pieces at the side to reduce waste and also create more design options. She believes in a "design practice that embraces uncertainty as a way of responding sensitively to both materials and instability of the environment" (McQuillan 2012). Yohlee Teng has been successful in reducing waste by replacing seams with folds (but these do not include facings, interlinings, etc.) (Rissanen 2005), using extra material for ties and knots. She has also experimented with the Mobius strip (Clark 2012). The drawbacks of these methods are that they employ complex procedures of pattern creation which require skilled designer and cutter to be successful. Also, they belong to the 'slow fashion' design process, one that remains a challenge at large-scale production. Their goal is not to minimize the fabric used but to eliminate the concept of waste creation (McQuillan 2012).

A-POC (A Piece of Cloth) by Issey Miyake gives the consumer the choice of cutting out their required garment from a running tube of fabric with cavities within. The major advantage being the elimination of sewing in the knit versions and minimal sewing in some woven garments. However, making them could be a problem as most manufacturers would not have access to technological requirements of A-POC garments. Furthermore, the responsibility of waste creation and management is passed on to the consumer (Rissanen 2005). Issey Miyake's designer Dai Fujiwara also combined advanced mathematics with fashion for one of their collections. Drawings by

William Thurston (a pioneer in the field of low-dimensional topology, 1982 Fields Medal winner, and professor of mathematics and computer science at Cornell University at the time) inspired Fujiwara. Another recent designer to experiment with topology is Arena Page. Her collection inspired by the Mobius strip got the attention of many in the field. The use of the Mobius helped reduce the number of patterns.

A similar concept to A-POC that uses a ‘tube of fabric’ is the Subtraction Cutting methods by Julian Roberts. Roberts’s methods involve cutting/removing the unwanted portions from the material i.e., the pattern is the negative space. In this case, the pattern generates design unlike the conventional methods. This integrated process defies in many ways the rules of garment design, shape and form (McQuillan 2012). Roberts’s defines sustainability as “Work and objects which are made that attempt to reduce waste, be made from materials which are renewable, or using processes which limit the impact of material and energy waste, and which are manufactured in an ethical way without devaluing the maker or exploiting them.” While not 100% yield, Subtraction Cutting drastically reduces waste when compared to its conventional counterparts. The only drawback is the consumption due to the use of two layers of long lengths of fabric to achieve the beautiful distortion/reorientation.

Designers like Issey Miyake, Yohji Yamamoto and Rei Kawakubo of *Commes des Garçons* are inspired by age-old techniques of wrapping and draping the body (Clark 2012). The Greek himation and Indian sari are perhaps the most ideal—a rectangular piece of fabric draped without any cutting. Another similar approach of unifying patterns can be seen in the works of Dr. Rickard Lindqvist. He too draws inspiration from drapes and simple cuts to create single-pattern garments like shirts, trousers, jackets, etc. (Lindqvist 2013). When I asked him about the challenges he faced when trying to achieve these patterns he said:

The challenges are to understand the properties of the fabric and the physics of the body and get them to work together. If the design becomes successful and long-lasting that might be a sustainable quality, however sustainability has not been a parameter in these experiments.

While Lindqvist admits that sustainability has not been a factor of consideration, his designs do comply with the proposed solution of reducing the 3 C’s for a sustainable model. Sustainable fashion not only has a positive impact on environment and society but also on the designer. Roberts’s wrote the following of his opinion on working within a sustainable framework:

The benefits are that we as designers are doing a better and more complete job rather than being lazy and doing a half or quarter job!

If you are a real maker, then you respect other makers, and when you work respectfully you get better results from your team of collaborators. Better design, better manufacture, better products.

8 Rethinking the Designer's Role and Design Process

Change is an intrinsic attribute of fashion and with changing trends and styles, there exists a pressing need for a more evolved, aware and intelligent generation of designers. In today's fast-paced, socially connected world the avenues and opportunities for creative individuals are diverse. However, our needs and goals have changed over the past few years as sustainability becomes a huge challenge that must be overcome. Fashion as a field of knowledge has recently drawn the attention of those within the industry who seek interpretations about their professional role. The association between fashion and sustainability is an area of growing study.

Fashion and clothing can be regarded as distinct concepts; fashion is immaterial, while clothing is material. While it is essential and understandable to promote creative ideas, it is of equal importance to create intelligent fashion that has the capacity to be successful commercially and sustainably as well. It is important to understand the role of a designer and the goals that the industry aspires to meet. It is primarily essential to instill in the minds of design students that design generation begins from a concept that inspires, to an idea that is creative, to finally innovation that has utility. Inspiration is a by-product of extensive research. A well-researched designer is often more inspired than one that is uninformed. This is typically because research creates opportunities for further research. It helps understand existing developments and areas that can be developed, thereby stimulating the growth of worthy ideas to explore. Although significant importance is majorly given to creativity, we must agree that creativity is simply the bridge from inspiration to innovation; it is not the end goal itself. Creativity explores ideas but experimentation and implementation of holistic solutions with a greater purpose lead to innovation.

Design is key to a sustainable future as its inherent nature drives to create visions for the future (Obregón 2012). Hence, it is vital that designers must take on a new role as agents of change. However, these agents must have sufficient knowledge in order to influence mainstream market (Fletcher and Grose 2012). The next generation of designers must first be trained to shape the future and cater to its urgent needs of sustainability. In 'Sustainable Thinking- Ethical Approaches to Design and Design Management' Aaris Sherin points the need for design thinking, strategy and innovation to be vital skills for designers (Rothenborg 2016). The emotional connect between clothing and the human psyche can be a driving factor and influence designers to explore sustainable ideas (Clark 2008).

The current generation of designers are engulfed in the fast fashion system which is more often than not accompanied by boredom eventually. Boredom for a designer can be very creatively destructive especially when the designer still continues to work in such a monotonous environment. He/she is now part of a system that encourages a continuous pattern of safe design without any significant and relevant growth personally to the designer or to the global fashion industry. These designers find it difficult to escape such a scenario due to their fear of risk taking that has been instilled as a result of being fed on an ideology of aesthetic value, numbers and profits rather than creativity and purpose. In India, we see a strong emphasis on surface embellish-

ments. Synonymous with embroidery, Indian designers for many years have been creating more or less the same pieces with different embroidery and embellishments on them. It is important to realize that ornamentation and surface enhancement are basically forms of value addition and not core design. Greater emphasis on them will corrode the purpose and significance of ‘design’. A fine example of this is Art Deco. The exaggerated use of decoration made it lose its value and meaning (Rothenborg 2016). Having said that, it is not implied that sustainable products must be stripped of aesthetic value. Instead, designers should use their aesthetics as a powerful tool to influence consumer behavior and overconsumption (ibid).

A sustainable agenda that transforms the role of the designer and pushes it beyond just an aesthetic creator needs to be established. The purpose of the designer is no longer limited to creating the product. It now extends to designing the process of make, use and dispose (Rothenborg 2016). The priority must shift from the end product to the design process. Involving the consumer in the design process does not mean allowing them to design for themselves. The designer still remains at the center but works more inclusively (ibid).

9 Value Addition: Renewed Status

Synonymous with ornamentation and addition of physical attributes, value addition is now viewed also as a more holistic relationship between personal expression, form/body/space, industry and manufacturing. Thus, making it more inclusive and emotionally/responsibly vested. Researchers believe new strategies like emotionally durable design could help extend the lifecycle of a product. An intrinsic facet for such a strategy is innovation. Sustainable and eco-fashion are very often bereft of design innovation as they focus more on the raw material. Gwilt (2009) advocates:

Innovation must not be compromised in pursuit of better sustainable practices if we accept that these new parameters are an integral part of the fashion designer’s brief.

A study by Muslu (2012) to inquire the importance of innovation within fashion brands for consumers shows 82% of the people questioned declared that it was important or very important. Only a mere 7% responded with “not very important” or “not important at all”. This proves that consumers want fashion brands to be innovative (Muslu 2012). Co-creation too adds new value to the product. It retains the DNA of all its participants while also creating a completely new original identity of its own. Julian mentions in *The Cutting Circle*:

Our own humanity is revealed in our actions and sensitivities as makers. (McQuillan et al. 2013)

The consumer is more likely to invest in such a process. Design that can relate to people is successful in driving change. Verganti (2009) states:

“People do not buy products, they buy meanings”, affirming the need for inclusion of a meaningful progressive process, as is seen in collaborative design, to be an intrinsic aspect of value addition.

Gwilt (2009) mentions how the quality and workmanship of haute couture garments incited consumers to care for their clothes. Examples from 1950s show that garments were often reconfigured in a number of ways over a period of time to extend the product's lifecycle (Gwilt 2009). The idea of after sale service was a common practice back then. Fashion brands must reintroduce this practice as it will not only improve product longevity but also will help establish a better relationship with the consumer. This will in turn also stimulate brands to reflect upon the quality of raw material, design and manufacturing. A WRAP (2012) report suggested that by increasing the active use of a garment to 3 years from the current 2.2 years in UK, there would be a 20–30% saving each for carbon, water and waste footprint (Gwilt 2014).

As part of after-sales, brands can also introduce up-cycling as an excellent strategy to give the consumer a sense of new value for their old clothes. Up-cycling not only helps extend the lifecycle of a product but also helps solve a common fear associated with mass fashion among consumers of running into someone else wearing the same dress (Zhekova 2013). Furthermore, these companies should engage young people at schools and universities in such activities as part of internship programs. Such an approach will “inspire the next generation to develop more responsible attitudes to the way people consume clothing” (ibid).

10 Solution: 1. Role of Education

Education can be interpreted as the process in which and by which knowledge, character and behavior of humans is shaped and molded. It is said to be the foundation of societal development and growth. For a formative change to occur within our fashion system and to facilitate sustainable development, it is crucial for the education model to witness a dynamic change. The acquiring, transfer and exchange of knowledge is however not limited to classrooms. The current chapter hints at a three-part model for education.

1. First comes our traditional methods of education that have been prevalent for centuries. This is a formal approach with already established norms that may be difficult to alter. One of the major concerns in such a system is its resistance to widespread change and the insecurities associated with sharing of ideas among students.
2. The second approach is a step forward in the direction of open network of ideas and sharing of concepts through the practice of collaborative and participatory design. Collaborations are essential for sustainable development it promotes careful attention to relationships, decision-making fairness, and leadership (Chrislip and Larson 1994; Hartman et al. 2002).
3. Finally, it is also equally vital to development that existing brands and companies educate their workers and employees for a new world of better ecological and ethical stability. They need to shoulder the responsibility for a sustainable future

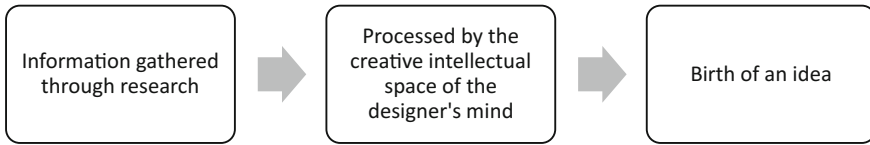


Fig. 3 Process of generating ideas

if we ought to see any real change. Big companies also have the advantage of reaching out to a wider section of the market and have the potential to educate the consumers at a faster rate compared to other stakeholders.

10.1 Institutes, Universities and Schools

Our education models may have begun creating awareness about the growing problems of unsustainability in the fashion industry. However, they fail to educate and teach students the means of incorporating ethics and achieving sustainability in their method of functioning. The general perception of sustainable eco-fashion still remains fixed at the use of organic fibers and low-impact dyes both of which are not created by the designer. Most young fashion design graduates still don't look at sustainability beyond the context of materials and production. It is still perceived as a trend rather than a different way of thinking (Fletcher 2008; Obregón 2012). The designer essentially has no direct control over these aspects of raw material and production; he/she can only make a sustainable choice from the available resources. It is important to outline the role of the new-age designer as someone who creates alternate methods of sustainable design, one where the roles of the designer and producer are merged to provide more holistic solutions.

Only a small percentage of the current generation of design students take a deep interest in understanding their roles and work on ideas with an innovative agenda compared to the greater population that is fixated on glamor and the ridiculous "nowness" of fast fashion. This majority is drifting away from research as an integral part of the design process to give more importance to rather superfluous subjects like social media. Although important in these times of technological advancement, information on social media cannot replace research as it is unaccounted for and there usually exists no proof of its authenticity. The quality of ideas being generated need improvement but for this we must first understand how ideas are materialized. It is proposed that an idea is a processed reaction to information. The Fig. 3 indicates the basic general process of idea generation. Information is collected through research thereby making research a key aspect for development and implementation of real change within the fashion system or any system for that matter. This information is then processed by a designer who by such time is already motivated and inspired by the information he/she has read, and then reacts giving birth to an idea.

Once brimming with ideas, students face the next problem of sharing of these concepts with their peers. While it is obvious to expect protectiveness in concern with their work, it is highly counterproductive to the essence of being a designer—a free thinker must also be willing to share freely. A selfish attitude to sharing will only lead to a generation of designers who are insecure of their own talents and are unwilling to take risks for the greater benefit of people, planet and profit.

Julian Roberts is a refreshing example to learn from. He invented his own technique of pattern cutting known world over as Subtraction Cutting. Roberts maintains an open platform to view, download, share, try and use his technique through his website where the e-book is available for free. Through workshops and masterclasses he educates students and teachers about his methods. He inspires them to interpret and use his technique in their own ways to broaden their creative perspectives associated with pattern cutting. There have been examples of other brands/labels using his technique while adding their authenticity and flavor. Instead of being insecure and lashing out claims of plagiarism, Roberts prefers to encourage them as he sees it as a positive development in the fashion system in its entirety. A quote that comes to mind and one that he invigorated me with in one of our conversations, “Not deep the poet sees, but wide.” Hoarding of ideas may seem rational on the surface but it limits the potential of the idea to grow and become bigger than the individual itself. In *The Cutting Circle* the superficiality of the designer is discussed as:

The industry maintains a strict veil of glamour around the notion of what a designer is and does, often ignoring the many hands that go into the production of clothing. (McQuillan et al. 2013)

A strong reference to the importance of the patternmaker, one of the “able production people”, is made with an emphasis on changing its perception as a “dry practice” (McQuillan et al. 2013) of geometry. Furthermore, *The Cutting Circle* suggests an approach to critical making for shared experiences to be amalgamated with pattern making to expand and improve our current education model (ibid).

We must encourage design students to work towards-

- (a) developing their design interpretations that are in sync with their respective aesthetics by thinking beyond the boundaries of the knowledge of just one area of study, and
- (b) instead of asking them to merely look for answers to the questions in the book, we need to encourage them to find new questions altogether, upon which new discussions, research and development can be carried out.

The student is constantly pressured into ‘thinking out of the box’, a phrase that essentially has no definite meaning. How do we define what ideas are inside the box and what are out of it? It would be wiser if we thought ‘without a box’ altogether. Creating/defining boundaries can be counter-productive. Students though aware of the need to engage with sustainable practices, are unaware of how to do so.

We now require a shift in the education model so as to be able to produce creators rather than just creatives. With too much emphasis being laid on creative ideas, designers have lost touch with innovation; its challenges and benefits are known to

only a few. The existing methods of teaching need to be reviewed and altered so they become easier to imbibe by the student who is relatively new to the entire subject and its process. It is essential for the next generation of designers to strongly consider sustainability as an important parameter of 'good design' especially at a time when the fashion industry has become a major contributor to environmental distress owing to its unsustainable practices. Therefore, educationists, teachers and mentors need to bring about a new wave of change into the methods of distributing, assessing and gathering knowledge that will enable students and future designers to meet the current needs while at the same time staying true to their emotional/creative zones.

10.2 Importance of Patternmaking

In the garment industry, products are only as good as the patterns they are made from. Today, several tools for patternmaking are available to ease the job of performing repetitive time-consuming tasks, enabling companies to cater to the fast paced fashion industry (Anderson 2005). Fabric was regarded as a coveted resource during the late medieval period when weaving was a laborious task (ibid). Rectangular uncut pieces were used to fashion clothes so as to minimize waste. When pattern making began in the fifteen century, it saw the dawn of a new epoch of engineered pieces of fabric that were cut to fit the body's shape. While this new division in clothing generated more scope for designs, it on the other hand produced a detrimental consequence where fabric took a back seat to fashion. Before the Industrial Revolution, fashion was customized and the role of the patternmaker grew in significance. Tailored clothing was more elaborate and most often a symbol of social status as it was for only the very rich. With the arrival of the Industrial Revolution the art of making clothes became a more homogenous process as there was a shift from customization to standardization (Anderson 2005). As technology advanced the use of computers by clothing companies began in 1980s (ibid). Patterns can now be created on a computer screen and changes and style details can be altered by moving a mouse or stylus thereby speeding the process to match the increasing demands of the manufacturer.

Where these technological advancements have simplified and eased the pattern maker's job, it has also simultaneously slackened the intent for exploration and experimentation. Earlier clothes were created on a three-dimensional human form; they were later made using two-dimensional paper patterns (the maker had been isolated from the actual human form); they are now drafted on a computer screen where any physical feel has been completely replaced with virtual interpretation. The maker has become more and more aloof from the end user through the passage of time.

As McQuillan et al. (2013) discuss melding of critical making with patternmaking for a more comprehensive education system, several students look to patternmaking as a feared subject. Since its advancement through the years, the process of patternmaking has developed the notion of being presented as a highly technical and mathematically complex science (McQuillan et al. 2013). This approach is conflicting to the

socially-established or perceived status of a designer as a creative genius. The divide between creativity and technicality can be seen as one of the important reason for the extrication prevalent in the design process and the fashion industry at large. Patternmaking must be regarded as a core area of interest, study and exploration. A shift in emphasis from accurate manifestation of the designer's sketch to a more holistic approach that encourages patternmaking and design to meet as equals is required.

10.3 Collaborative & Participatory Design

Intellectual expansion within design is becoming increasingly important. With growing globalization and technology, social and scientific inputs play an equally important role in the design process (Rothenborg 2016). Therefore, design must be open to a multidisciplinary approach for innovative solutions. Fashion needs to diversify and seek inspiration from various areas of study by not limiting itself to just the glamorous and obvious. Such a system can only be realized through collaborations and participatory design which is in contrast to the vast majority of a closed and guarded approach to the design process in the fashion industry (McQuillan et al. 2013). A co-creative attitude will not only bring back excitement to the design process but will also expand our avenues for research. However, for the success of this system designers will have to shed their prides, egos and insecurities associated with sharing of ideas for the greater benefit of the industry, its people and environment.

During The Cutting Circle, a collaborative international research initiative by Timo Rissanen, Julian Roberts, Holly McQuillan, the three fashion designers and educators worked in each other's design space and "enjoyed the free transfer of ideas and cross-pollination" (McQuillan et al. 2013). Such a mutually vested interactive process makes it easier to identify collective abilities, links, gaps and opportunities (ibid). All their methods required the ability to pattern cut 'from nothing' rather than a response to a sketch. One of the major benefits outlined was in regard to how they were driven to work out of their comfort zones and adapt to each other. There is a constant emphasis on critical making rather than critical design where the former focuses on the 'how to' aspects of the work (ibid). The goal of critical thinking according to Ratto (2011) is the "creation of novel understandings by makers themselves" (McQuillan et al. 2013). It is about sharing the process and making experiences. The true aim of co-creative design is to find new ways of thinking about making, discovered through the act of making (McQuillan et al. 2013; Ratto 2011). The method adopted for The Cutting Circle is described as "a collaborative design team, engaging with something that could be called critical pattern making" (McQuillan et al. 2013).

In a more mainstream context is the successful collaboration between Stella McCartney and Adidas that began with the Spring/Summer 2005 collection and is still ongoing. Stella McCartney has been a proud supporter and advocate for sustainability within the fashion industry. She uses organic fabrics and low-impact dyes, all the while maintaining the aesthetic appeal of high-fashion luxury. She is aware of the growing problems within the industry and the lack of attention it gets. She says:

It seems to me that fashion is the last industry on the planet to address ethics. (Stella McCartney 2017a)

She also accepts that there is no fully sustainable model at present and being a true environmentalist is impossible to do while running a successful business (ibid). Adidas on the other hand, is a sportswear brand who are not particularly known to have any significant sustainable strategies in their business model. However, their collaboration with McCartney provided a platform for sustainable solutions packed in aesthetically designed sportswear. Their collections incorporated the use of organic cotton, recycled yarn and the dry dye technology among other efforts to reduce environmental footprint. Their use of advanced eco-friendly cutting techniques ensured just 5% waste, i.e. 95% of fabric was used to create the final product. The waste too was recycled or repurposed so there was essentially no surplus material going into waste, adding to their product's sustainability index (Stella McCartney 2017b).

Adidas being a mainstream mass manufacturing brand can create a great impact by going sustainable. Sportswear's use of polyester fabrics, unsustainable dyes and chemical treatments was seen as a major concern but with the collaboration of Stella McCartney and Adidas proving to be such a remarkable success, it has created scope for more such brands to turn sustainable in a large scale set up. Another advantage is expansion of the target market. Adidas is a mass brand catering to a larger target market compared to Stella McCartney who as a luxury designer caters to a niche audience. While both Stella McCartney and Adidas benefit hugely from such a collaboration, it is the consumer who gets the greater advantage. The consumer while buying a product from the collaborative collection can now own a designer piece of sportswear at a fairly affordable price and with better sustainability offerings. It's a win-win situation for both designer, producer and user. Of course their products are not 100% sustainable but it is surely a conversation starter. Collaborative design offers a fresh new facet to the perception of value addition. Collaborative and participatory design can bridge the gap between designers and consumers, makers and producers thereby leading to an industry which is capable of doing everything better (McQuillan et al. 2013).

10.4 Brands and Companies

Apparel companies play an imperative role in influencing consumer behavior. These brands and companies have the power to affect buying decisions and hence have relative power to change consumption patterns as well (Muslu 2012). By providing important information through labelling, packaging, etc. these fashion brands can increase awareness of the consumer about sustainable consumption. In a study by Cone Communications (2013) 85% respondents indicated the desire to be educated by companies regarding how to properly use and dispose products (Kim and Hall 2015). While design innovation holds a major stake in the sustainability index of a product, companies have focused on sustainable raw materials to initiate a greener

approach to fashion and retail. Leading fashion companies “should design and use recycling systems actively, not only to avoid the impacts of new fabric production, but also to be a model for others in the industry” (Muslu 2012). Adoption of sustainable solutions by a fashion company can thence inspire competitor brands to implement similar models and also motivate them to develop innovative solutions for sustainability (ibid).

An integral part of reaching sustainability goals requires fashion companies to adopt self-regulatory practices through the framework of Corporate Social Responsibility (CSR). Among the theoretical agendas aimed at classifying the role of business in society, CSR has over the last couple of decades become increasingly focused on corporate strategy. Financial and competitive goals are now closely associated with the concept (Bianchi et al. 2014). Today, CSR is a valued strategic resource that can improve the bottom-line performance of a corporation (Bianchi et al. 2014; McWilliams and Siegel 2001). CSR policies have a positive impact on human resources and enhance employee relations. This in turn leads to low employee turnover rate along with improved employee motivation that could reduce absenteeism (Bianchi et al. 2014). There has been notable evidence that CSR encourages innovation through social, environmental or sustainability drivers. In fact, Bianchi et al. (2014) highlights:

innovation performance is the most direct and effective competitive implication originating from CSR initiatives

Such innovative strategies have the potential of being communicated to other organizations through the supply chain, thus creating a virtuous cycle (Bianchi et al. 2014; Little 2006)

Retail giants like Marks & Spencer, Nike, H&M, and Zara have employed sustainable programs to help improve the environmental and ethical performance of their goods and services (Gwilt 2014). Brands have the potential to better understand the consumer through interaction through which constructive opportunities for value creation can be identified (Kozlowski et al. 2014). Zara has been using ecological fabrics, bio-diesel fuel, etc. apart from building awareness among its staff. The 200 million pieces of clothing manufactured annually are transported using bio-diesel fuel in the ratio of 5%. This alone has reduced Zara’s CO₂ emissions by 500 tons (Muslu 2012). After the tragic collapse of the Rana Plaza in 2013 H&M has taken several measures to be sustainably proactive. Since 2013, they have collected almost 39,000 tons of garments in H&M group stores, which is equivalent to 196 million t-shirts. In 2016, H&M became the second largest user of recycled polyester in the world by using recycled polyester equivalent to more than 180 million PET bottles (Burt et al. 2017). Levi’s® is among the most popular denim brands available. The processes involved in the manufacturing of denim consume large quantities of water. Levi’s Water < Less™ initiative helped reduce water consumption in the finishing process by up to 96%. Over 13 million Water < Less™ products were manufactured for their Spring’12 collection and the brand saved over 172 million liters of water (Levi’s® Water 2014; Kim and Hall 2015).

Reformation is a women's lifestyle brand designed and manufactured in Los Angeles that lauds itself as one of the most sustainable mass produced brands available. While the price points are on the higher side, the brand has still managed to create a global buzz. The brand uses sustainable materials including deadstock fabrics, measuring each garments impact on its Ref Scale, and prides itself on ethical manufacturing practices. Reformation's transparent display of information regarding waste footprints, CO₂ emissions, water consumption, etc. is available for all products and is visible to the consumer (Reformation 2017). Therefore, the consumer is educated about the environmental footprint that he/she would be avoiding by investing in a product of the brand. Information must be made transparent to the consumer to help them make more conscious purchase decisions.

In the recent times, Nike has embedded sustainability and innovation as a key driver as part of their long-term business goals (Nike 2014; Kozlowski et al. 2014). Their Chief Sustainability Officer & Vice President, Hannah Jones articulated Nike's roadmap for a sustainable future:

We are constantly integrating more sustainable ways of working across our business. But we recognize that many issues facing business and society are greater than one brand can solve alone. To achieve systemic change we must understand the risk and embrace innovation as a way to accelerate positive impacts at a scale. Collaboration and unconventional partnerships will be critical to our collective ability to design more sustainable business systems. (Nike 2014)

The Nike + platform created in 2006 as a joint venture with Apple was though not directly linked to sustainable design but demonstrates scope for consumer behavior change. Using Nike + users could track, measure, compare, dissect current habits, and share exercise performance globally (Kozlowski et al. 2014; Nike 2012). It is interesting to note that Nike developed such technology just a year after Adidas collaborated with Stella McCartney in 2005. While there is no evidence that Adidas's sustainable collection could have provoked Nike to promote a sustainable innovative system, it may have been one of the reasons. The Nike + system encouraged its users to form healthier, long-term lifestyle habits and consequently also long-term attachments to the devices themselves. By creating a service that became vital tools to motivate users to adopt an active lifestyle gave Nike a new way of generating profits from innovative products and services along with market growth (Kozlowski et al. 2014).

Although Nike's vision was not sustainability, it helps prove the point of how brands can change consumer behavior by using innovative methods that involve risk-taking. Nike's use of technology in fashion design has been able to engage the consumer in the product well after its purchase, thereby supporting the theory of behavior change for sustainable consumption. If Nike has been able to facilitate change for an active lifestyle, possibility exists for fashion design to facilitate behavior change for sustainable consumption (Kozlowski et al. 2014).

All in all it is essential to understand that when a fashion company adopts sustainable measures in even small ways the impact that is created is substantial due to the scale at which these companies operate. A simple example is H&M's adoption of 100% recyclable plastic cases and reusable boxes for transportation which

has helped save 400,000 trees each year (Muslu 2012). Additionally, companies can incorporate policies to support environmental causes through the sales of their green products. Loomstate is one such company where consumers purchasing their T-shirts indirectly support company participation in beach cleanup projects, wildlife conservation efforts, and upcycling projects (Kim and Hall 2015). While these companies are making efforts to implement sustainable systems and practices, it is of utmost importance that this information be transparent and available to the consumer.

11 Solution: 2. Use of Topology

Topology is regarded as the mathematical study of the properties that are preserved through deformations, twistings, and stretchings of objects without tearing. Weisstein (2017a) explains: “a circle is topologically equivalent to an ellipse (into which it can be deformed by stretching) and a sphere is equivalent to an ellipsoid. Similarly, the set of all possible positions of the hour hand of a clock is topologically equivalent to a circle (i.e., a one-dimensional closed curve with no intersections that can be embedded in two-dimensional space), the set of all possible positions of the hour and minute hands taken together is topologically equivalent to the surface of a torus (i.e., a two-dimensional a surface that can be embedded in three-dimensional space), and the set of all possible positions of the hour, minute, and second hands taken together are topologically equivalent to a three-dimensional object.”

Topology is a vast concept that initiated with the spatial objects such as curves, surfaces, the space we call our universe, the space-time of general relativity, fractals, knots, manifolds (which are objects with some of the same basic spatial properties as our universe), phase spaces that are encountered in physics (such as the space of hand-positions of a clock), symmetry groups like the collection of ways of rotating a top, etc. A core notion is the treatment given to spatial objects like circles and spheres to be considered objects in their own right (Weisstein 2017a). The understanding of objects is independent of how they are represented or embedded in space.

For example, the statement “if you remove a point from a circle, you get a line segment” applies just as well to the circle as to an ellipse, and even to tangled or knotted circles, since the statement involves only topological properties (ibid).

The concept of amalgamating design and science has usually been attributed to electronic or computerized mechanisms/engineering that are often very expensive processes. Design practices that have demonstrated the combining of topology and patternmaking have been successful in attaining sustainability in design and are also more feasible.

It can be observed from Table 1 that methods that draw inspiration from topology have been successful in innovative design creation that also has sustainable benefits. Some designers have deliberately chosen certain concepts that align with their design process while for some it has been accidental. Although there are several topological

Table 1 Results of use of topology in fashion design

Method	Result
Holly McQuillan's zero-waste patterns are achieved using the concept of tessellation	Eliminates waste completely
Yohlee Teng's use of origami and Mobius strip	Reduced consumption and wastage
Issey Miyake's origami and topology inspired (William Thurston) clothing	Folds and drapes to reduce waste
Arena Page's collection inspired by Mobius strip	Reduced number of patterns
Julian Robert's displacement technique and understanding of 3D space	Reduced wastage
Dr. Rickard Lindqvist's analysis of the physics of the body and wrapping around it	Reduced seams and cutting time

concepts that can be incorporated into fashion, this experiment explores the Mobius strip to create Planar Flux—a hybrid clothing technique.

The Mobius strip is a mind-boggling mathematical concept that has for years been researched. The strip creates the illusion of being double-sided (like a garment) but is actually just one-sided in reality (Weisstein 2017b; Herges 2005).

Making a Mobius:

A Mobius strip can be easily made using a paper strip. As shown in Fig. 4 the strip is given a half-twist and the ends are joined to form a loop. However, the Möbius strip is not a surface of only one geometry (i.e., of only one exact size and shape), such as the half-twisted paper strip depicted in the illustration. Any surface that is homeomorphic (homeomorphism according to the Collins English Dictionary (2017) refers to a one-to-one correspondence, continuous in both directions, between the points of two geometric figures or between two topological spaces) to this strip can be considered a Mobius band. Since its boundary is a simple closed curve which is homeomorphic to a circle, Fig. 5 illustrates a circular Mobius.

The unilateral topology of the strip can be achieved in different ways. Varying the direction of the half-twist i.e., clockwise or anti-clockwise results in different embedding of the strip in Euclidean space. A clockwise twist is referred as right-handed and an anti-clockwise twist as left-handed. They are both mirror images of each other but are homeomorphic in each case (Stern 2000).

To prove that this piece of paper has only one side, a line is drawn starting from the seam down the middle on the strip, following the length of the strip. Without picking up the point of the pencil, going around the loop. The line will go all around the inside of the loop and all around the outside of the loop and finally meets the starting point; even though you never picked up the pencil to change sides, and covering double the length of the original strip. Thereby proving the Mobius strip only has one side (Doherty and Murphy 1999). If such an illusion could be created in garments it could be a solution to the issue of fabric consumption. Using this concept we can achieve the illusion of double the fabric used where it uses actually only half of it.

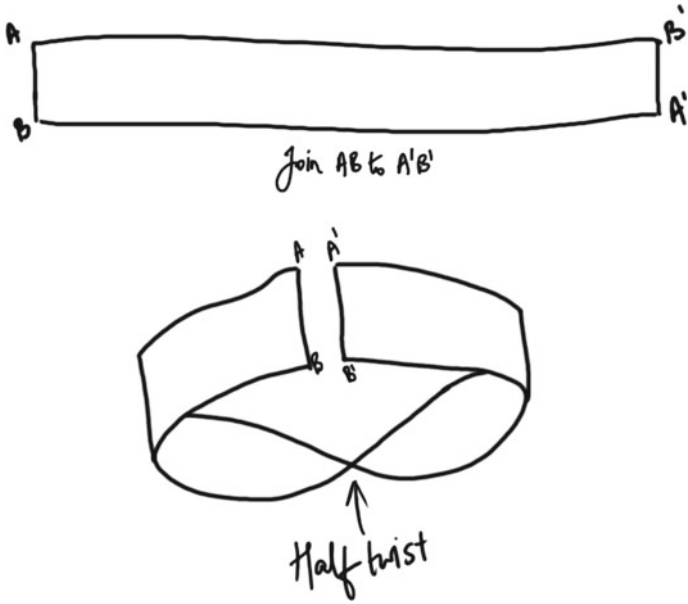
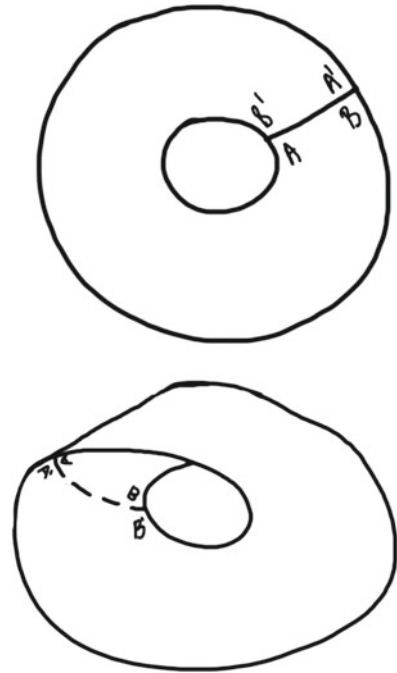


Fig. 4 Making a Möbius strip

Fig. 5 Circular Möbius



This experiment proves that the concept of Mobius can optimize the strip to double its original length and going by the same logic its application to garments could optimize the fabric to 200%? So a garment that would appear to use four meters would actually use only about two meters!

12 Planar Flux—A Hybrid Technique

This chapter sees the development of Planar Flux, a hybrid technique. The term ‘planar’ refers to the geometric planes in space, and ‘flux’ refers to the property of fluidity. The technique can be viewed as a derivative of the Subtraction Cutting technique. Furthermore, it may also be perceived as an evolution of the Subtraction Cutting technique. The name ‘Planar Flux’ is simply for the purpose of easier identification and to avoid confusion as its resultants are visually different from those produced by the Subtraction Cutting techniques of Julian Roberts.

While investigating the current systems of sustainable innovations, there exists scope for reducing the fabric consumption. Techniques like Subtraction cutting used two layers of long lengths of fabric to achieve the beautiful distortion/reorientation and although, the zero wastage techniques eliminate wastage, the area of fabric used still remains same more or less. There is a fundamental difference between waste consumption and fabric consumption. So why does it require so much fabric? Basically because of the volume that is created. But with no volume there would hardly be anything to explore and experiment with. Lindqvist (2013) states:

In addition to look upon fit and volume from a functional point of view, putting forward varying amounts of suggested volume for different types of garments, one needs to see how a certain volume and size of a garment affects the body wearing it. The concept of fit needs to include the notion of how the garment transforms the expression of the body, covering parts of it while revealing and accentuating other parts.

There is a need to create a technique that has both volume and reduced fabric consumption for this purpose.

An experiment of placing the basic pattern which until now was viewed as space itself, and placing it in a 3D space (Fig. 6).

When placed in a 3D space, the patterns are viewed on the XZ plane as shown. So since the pattern is the garment before it is stitched, it can be said that all/most patterning methods have only been using this XZ plane. The Y axis has not been explored completely. Even the most radical method i.e., subtraction cutting, involves a double layered fabric that is placed on the XZ plane. It is then stitched at the shoulders, placed on the dress form and then unfolds the drama. Some methods of subtraction cutting like the ‘Displacement’ technique does use the Y axis to some extent (Roberts 2011). But the problem of fabric consumption still remains. An important question is how the third axis could be used and what results could it yield? The answer, to a large extent lies in Julian Roberts’s methods along with a little understanding of math and physics.

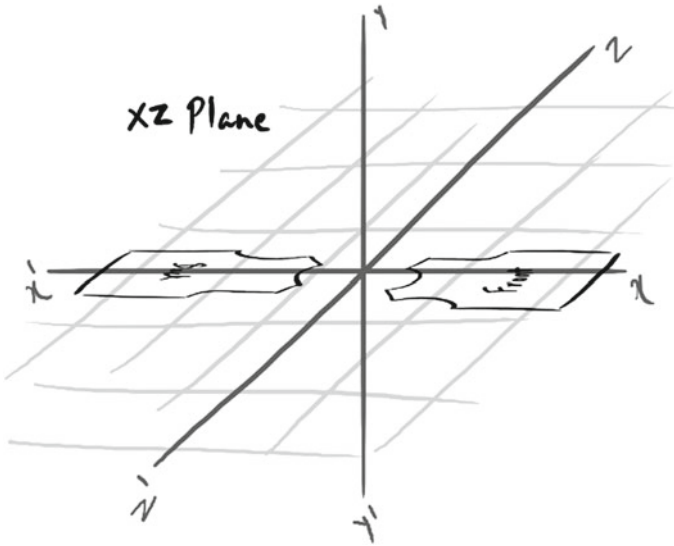


Fig. 6 Conventional pattern block in 3D Space

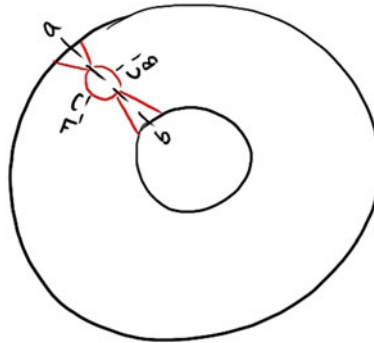
Planar Flux draws inspiration from the Mobius strip. The previous section explains the creation of a Mobius strip. Creating such a strip is possible by either using a circular or a rectangular strip. Since the circular strip would be able to provide more volume in comparison to the rectangular one, the experiment is carried out with the circular Mobius strip.

When a Mobius strip becomes the pattern by accommodating the neckline, shoulders and armholes, it results in a layered garment where the material is turned over in some areas depending on the twist of the strip, i.e. the wrong side of the fabric is visible on the right side of the garment in those specific areas of the garment. Figures 7 and 8 represent the adaptation of the Mobius into garment pattern and the resultant form developed by joining the diagonally opposite shoulders. So the front left shoulder here meets the back right shoulder in the figure.

This resultant ‘Mobius bolero’ is a Mobius strip’s most literal translation into pattern cutting. To diversify the possibilities and broaden scope, the concept of the Mobius is merged with Julian Robert’s Subtraction Cutting methods. Subtraction cutting is based on a model of design development through pattern cutting, a concept that is in alignment with the philosophy of Planar Flux that design generation is deeply rooted in pattern innovation. So instead of applying the concept of the Mobius to a circular strip, it is applied to the hollow space in the strip. Figure 9 shows the incorporation of Subtraction Cutting in Planar Flux. Here the difference is the fabric requirement as only one layer of 2–2.5 m length would suffice.

This hybrid pattern is again, as in the previous pattern, joined at diagonally opposite shoulders, i.e. **a** meets **b'** and **b** meets **a'**. It can be observed that when this pattern is flipped and/or turned to enable connecting the shoulders, it appears as though the

Consider an imaginary line 'ab'. Place the front & back patterns along either side of this line such that the necklines are aligned. Cut along the red line.



* Note that the patterns should be inclusive of seam allowance.

Fig. 7 Initial pattern development

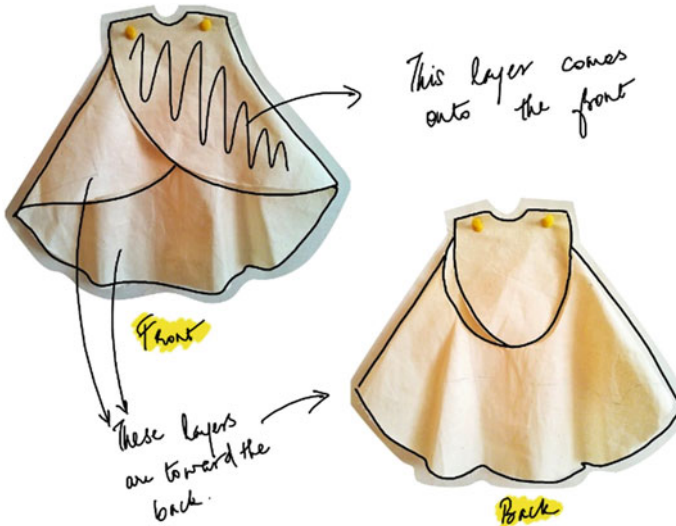


Fig. 8 Resultant garment

pattern is travelling through various axial planes if viewed in a 3D space. Taking the example of one of the patterns, Circle 1.1 (Sharma 2016), this can be understood in Figs. 10 and 11.

The pattern though placed on the XZ plane, moves through the Y axis where it twists/turns through certain degrees (in this case the front is turned by 360° followed by 180°) and then returns to the XZ plane. The dress in Fig. 12 gives the illusion of a voluminous layered garment that has a 3D crater effect created on the front, with

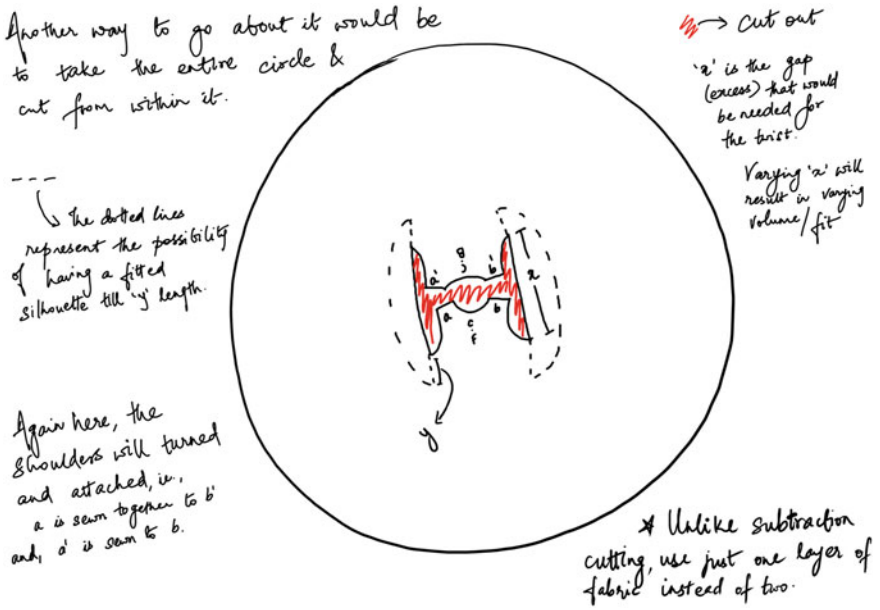


Fig. 9 Planar Flux-subtraction cutting hybrid

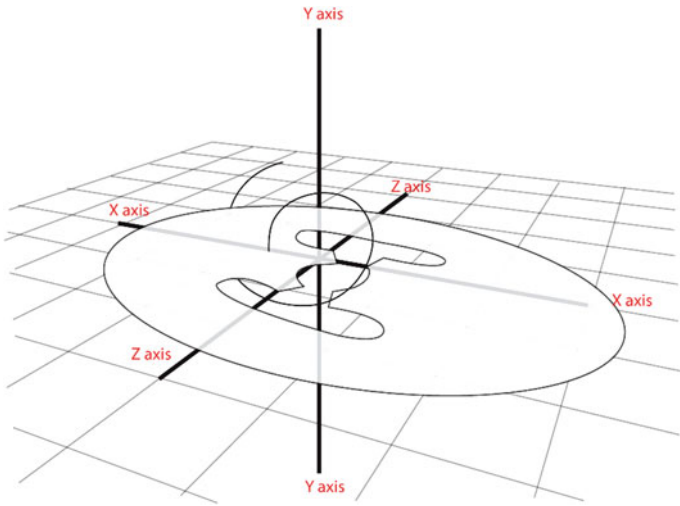


Fig. 10 Placement in 3D space

cascading and zigzag layers. The white piping is continuous and is useful in following the motion of the material. Thus, emphasizing that all layers are in actuality one single piece of fabric which thereby ensures minimal seams, adding to its sustainability index.

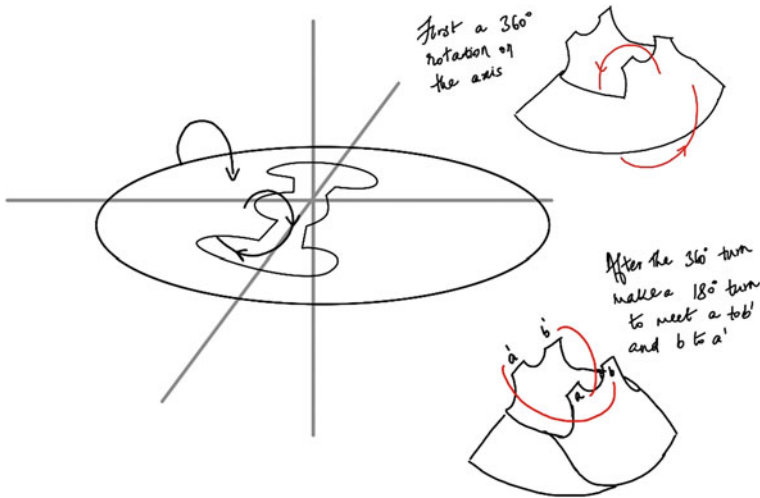


Fig. 11 Circle 1.1 planar pattern movement

12.1 *Planar Flux: Collaboration Leads to Improved Sustainability*

This chapter suggests collaborative design as an integral aspect of moving forward in the direction of a sustainable fashion industry for the future. To reinforce this ideology and prove its success, a collaborative project involving Planar Flux is cited below.

An example of collaborative design that has had a successful sustainable outcome is the project 'AlterEco' with Laura J Salisbury of London College of Fashion. The project was aimed at providing an alternate approach to design and manufacturing of garments that promotes sustainability and innovation. Salisbury, who was working on her masters project, was developing a fastening technique created using natural rubber. It was essential to her concept that it be employed in a sustainable garment design. Till such time Planar Flux had not explored bifurcates due to the foreseen limitation of unsustainable fastening methods. Our two concepts were therefore a great fit when brought together. The two collaborators, Salisbury and Sharma, worked from their respective locations i.e. London and Chennai, to exchange inputs and experiments. Interaction was through digital/virtual communication platforms constantly, determined to create a better solution together. An integral part of collaborative design is to have clearly outlined roles; to understand the aim of the project and invest creatively through the journey of it. Once the collaborators understand the true potential of their collective strengths and talents, any previous notions of insecurities diminish giving birth to a cohort of progressive free thinking individuals who appreciate sharing of views, opinions and ideas. After several explorations, it

Fig. 12 Circle 1.1 dress

was agreed that the Mobius trouser would be a fitting representation of both our concepts uniting to create an original design and product.

First, the experimental pattern was tried on a small form of a doll to test and understand the flow of fabric. The fastening would be positioned at the center back at the waist as shown in the Fig. 13. The Fig. 14 shows the initial prototype for the natural FSA rubber fastening (Fig. 15).

As can be seen, the fastening is a zero-waste one with interlocking pieces that act as the closure system. The final realized garment has been adapted and altered to suit the human form based on aesthetic appeal and also the fabric properties/dimensions. A closer view of the fastening in its use can be seen in Fig. 16.

The correlations and opportunities that collaborative participatory design can have and create extend beyond the area of study that the said work has been carried out in. For example, the 'AlterEco' collaboration was aimed at creating a more sustainable system of fashion that integrated design and manufacturing in a holistic manner. However, the thesis featuring this project has been accepted at the Kew Gardens library in London, where it may be viewed from a more botanical perspective in



Fig. 13 Representation of the Mobius trouser on a small form (doll)

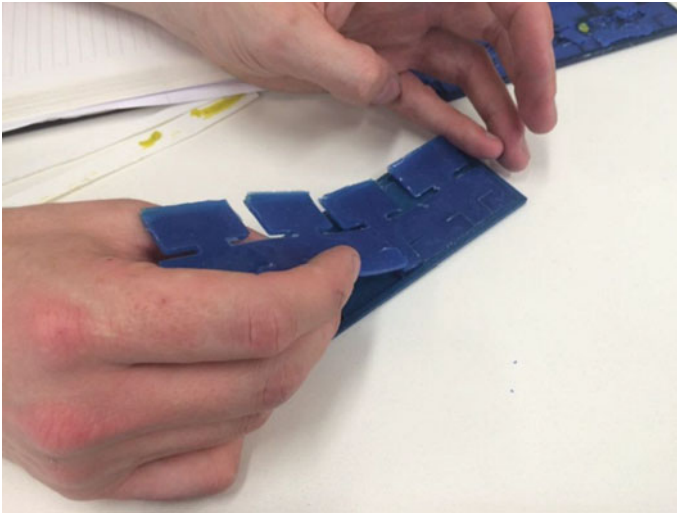


Fig. 14 Zero-waste rubber fastening prototype

order to, for example, assess the various uses of natural FSA rubber. A researcher or student may then interpret it with the agenda of promoting natural rubber in an industrial set up citing the example of the AlterEco collaboration.

12.2 Simplification to Optimize Sustainability

It is most certain that ancient forms of clothing that comprised of a piece of fabric that was draped/wrapped around the body; differently in different parts of the world, were the most sustainable examples of clothing. As time evolved we broke down the human form on cloth and started cutting and sewing pieces together. The simple piece of cloth had been developed for better fit through a more complex process

Fig. 15 Full-scale Mobius trouser



Fig. 16 Rubber fastening at centre back



that we call pattern making today. Over the passage of time the complexity of this process has increased with an increase in number of pieces sewn together for a single garment which has in turn led to more waste generation and unsustainability. While it is true that pattern making has furthered our understanding of the human body and the nature of clothing, it has drifted from the ideology of sustainability through simplification. Lindqvist (2013) explains:

Zero Waste Pattern Development

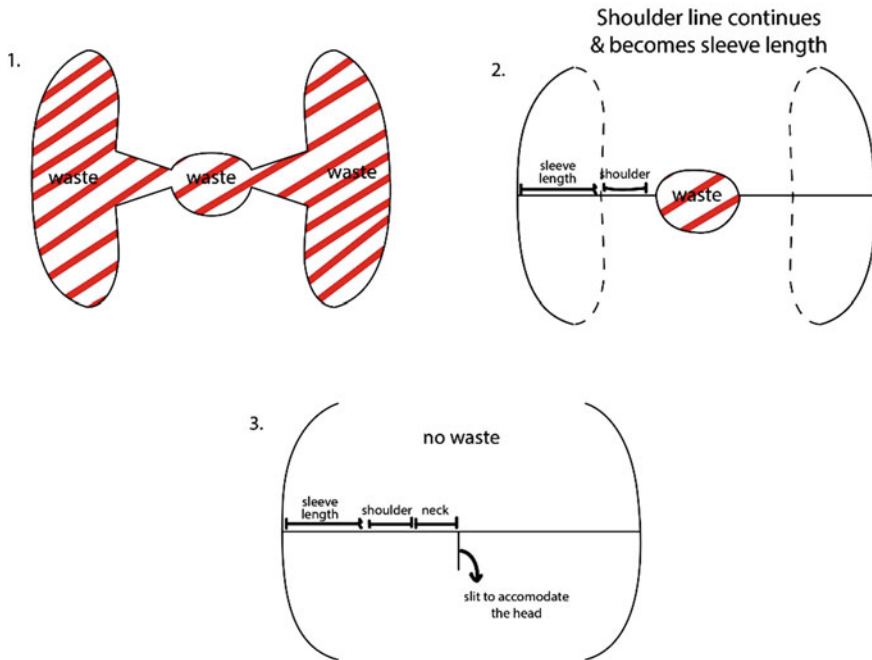


Fig. 17 Zero-waste pattern development

A pattern of a tailored sleeve tells us about an arm and a front body piece about the chest. The paradox is that this is also where the separation of the garment from the body begins.

Today's general idea of sustainability to a pattern maker is an efficient lay plan. There have been few examples of how the simplification of patterns can not only reduce number of pieces per garment, but also leads to a more innovative understanding of the physics of the body. Dr. Rickard Lindqvist's pattern making methods employ a unifying approach that shift and reorient the body on the pattern to minimize the number of pattern pieces. Another spectacular example is Julian Roberts Subtraction Cutting. Perhaps the most simplified approach, he suggests using a large piece of cloth and only cutting out (or subtracting), what is unrequired. Since Planar Flux is a hybrid of his methods, an attempt to simplify the pattern furthermore has been made. In the Fig. 17, the first step represents the typical Subtraction Cutting pattern that is used in the Planar Flux methods. Although this pattern reduces wastage to quite an extent when compared to conventional patternmaking, there is scope for further elimination of waste.

In step 2, the pattern is simplified to eliminate the armhole by straightening the shoulders and extending the line. The beauty of Subtraction Cutting is that the more

Fig. 18 Zero-waste half-scale sample



you simplify, the more fabric you add to the garment. So as we simplify, we have created sleeves in the process. The final step is to generate a zero-waste pattern. Here the neck, shoulder and sleeve are all aligned together in one straight line. A slit may be provided for the head to pass through. The curved bracketed ends can be converted into straight lines as well. A zero waste pattern is thus created.

The Fig. 18 shows a zero-waste sample created using the same twisting technique seen in Fig. 12.

Figures 19 and 20 show a full-scale zero-waste dress created using Planar Flux. The pattern remains the same as that used in Fig. 18 excluding the Centre Front slit. The placement and twisting varies resulting in a different design. Figures 19 and 20 represents a Zero-waste dress created using Circle 1.0 (Sharma 2016) technique of twisting the back by 180° and then aligning it with the front shoulder. For enhanced design variation here the excess has been converted into a draped three-dimensional pleating. The straight line of the neck, shoulder and sleeve has been dropped at one side to create a one-off shoulder design. The asymmetric hemline is achieved based on placement of the pattern on a rectangular piece of cloth whose dimensions are 2.28 m × 1.50 m.

12.3 Incorporating Planar Flux in Fast Fashion

Planar Flux appears to be a conceptually successful experiment. The endeavor is for such a model to be adopted by fast fashion brands to improve their quality of

Fig. 19 Zero-waste Planar Flux dress front



design innovation and enhance consumer engagement which can in the long run help change consumer behavior. Innovation that is not practically feasible or does not provide enough incentive for companies to adopt them, are ultimately futile. This section gives a brief overview of how Planar Flux can be integrated into fast fashion for greater benefits to the company.

To better understand the reasons for adopting Planar Flux into a fast fashion system, the criteria are categorized into:

- (1) costs associated with manufacturing
- (2) costs generated through sales i.e. profits.

For any existing or new company looking to employ Planar Flux design strategies and practices, both of the above mentioned criteria must be met in order to facilitate a successful business. The Table 2 implies that Planar Flux can be implemented using the existing infrastructure available to fast fashion manufacturing systems such that there is no extra capital cost required. Since Planar Flux reduces the seams due to the continuity of the material, there are lesser sewing operations, thus reducing the energy footprint associated with manufacturing for each garment. In a mass manufacturing setup this would mean a significant reduction in the running cost. Therefore, costs associated with manufacturing does not pose a threat to the acceptance of Planar Flux by fast fashion producers.

Fig. 20 Zero-waste Planar Flux dress back



Table 2 Capital cost versus running cost for Planar Flux in mass manufacturing system

Capital cost	Running cost
Same machines can be used	Lesser cutting and sewing operations means lesser energy footprint per garment
Easy to adopt in current manufacturing systems of fast fashion companies	Raw material consumption is reduced significantly
Capital cost remains unchanged	Running cost is cheaper

Any innovation is only good enough if it can generate sales for the brand. Sometimes innovative products may not generate profits but companies still manufacture them as long as they don't incur loss. On the other hand if profits are driven by an innovative product, companies will embrace the concept without any fear of risk. For the sake of example, let's consider that a layered voluminous evening dress (Dress 1) in polyester by a fast fashion brand like H&M costs \$70. This cost is inclusive of profit margins while using 'x' meters of fabric and energy. It is posited that a Planar Flux layered voluminous evening gown (Dress 2) in polyester such as the one in Fig. 19, be priced at the same \$70. This cost is inclusive of the profit margins (same as those set for Dress 1) plus the profits from consuming lesser raw material (half of 'x' meters) and energy. This indicates an increase in profit margins for garments

manufactured using the Planar Flux technique. From a consumer perspective, these products would be alluring to purchase. The consumer is accustomed to spending \$70 for a layered voluminous evening dress in polyester. When this consumer is educated on the added value i.e. innovation for sustainability in Dress 2 without any change or surge in pricing, it could become a driving factor for purchase of the product. Therefore, Planar Flux is a profitable business model for fast fashion companies to incorporate even if only as a parallel line.

12.4 Scope for Further Development

The idea of designing with patterns introduced by Roberts (2011) has proven to be an exploitable approach and is the future of the new-age design. As explained above, Planar Flux works on a design process where the concept is applied on the patterns and thus emerges the design which can then be sketched out to communicate its appearance/details, instead of the typical approach of sketching the designs and then making patterns for them. This new design process involves a certain mystery and uncertainty about its possible outcomes.

Since viewing patterns and garments in terms of axis has not been explored extensively, there is certainly scope of further development. The Mobius strip is a vast concept with several experiments and interpretations by physicists. Experiments with different twists and turns of the pattern and possible collaborations that aim at amalgamating other innovative techniques with Planar Flux can also be done in the future. Furthermore, the concept of combining a theoretical mathematical or scientific concept into practical design through patterns has been explored in this method hence proving that the two—design and science, can be brought together in a manner that is creative, productive and most importantly cost-effective.

Table 3 summarizes the comparison between the existing zero-waste techniques and Planar Flux to assess the success and drawbacks in both cases.

We can assert the success of Planar Flux as a sustainable innovative design technique. As we know about 60–80% of a product's sustainability is determined by its design. While Planar Flux may satisfy the design requirements for a sustainable endeavor, the remaining aspects like the use of eco raw materials have still not been explored. Moving ahead from organic fibers to a more advanced raw materials would be a positive step ahead. Several developments in textiles like Pinatex© who produce textile that mimics leather from pineapple fiber, to BioCouture by Suzanne Lee where textile is grown directly from microbes are inviting opportunities for Planar Flux to collaborate with to create a nearly perfect sustainable product.

Table 3 Comparison between current zero-waste models and Planar Flux

Existing zero-waste techniques	Planar Flux
Goal: Eliminating waste completely	Goal: Reduction in consumption, cutting and construction (3 Cs)
Requirement: Proficient designer & pattern cutter	Requirement: Nothing specific. Can be created by anyone with or without technical expertise
Seams: Remain more or less the same in number	Seams: Drastically reduced due to continuity of the fabric
Fit is easily achieved	Needs to be tested and explored for fitted silhouette
More volume would require more fabric	Volume is easily achieved without using more fabric
Fabric consumption remains the same more or less	Fabric consumption is reduced by nearly 50%
Waste is zero	Zero-waste design has been developed without compromising the goal

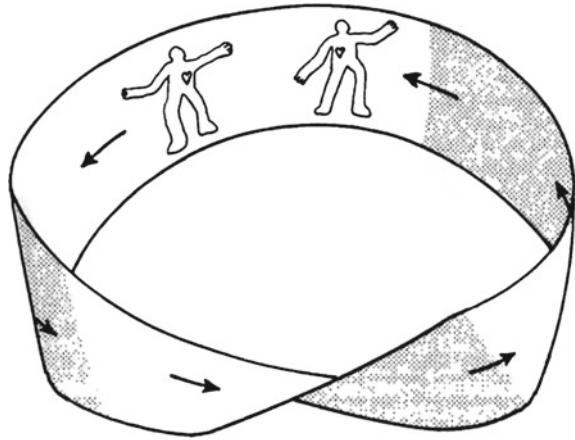
13 Correlation to Fourth Dimension

The Planar Flux is the first true representation of the fourth dimension in clothing since it works on the concept of the Mobius strip which according to researchers possesses four-dimensional characteristics as well (Mobius strip possesses multi-dimensional properties) (Weisstein 2017b; Physics Forums 2009). This clothing technique does not merely apply the outcome of the theory onto the garment (i.e. attaching Mobius strips onto a garment/silhouette) but applies the theoretical concept itself to the fundamental pattern.

Hilbert and Cohn-Vossen (1952) advocate: “As to geometry, in particular, the abstract tendency has led to the magnificent systematic theories of Algebraic Geometry, of Riemannian Geometry, and of Topology; these theories make extensive use of abstract reasoning and symbolic calculation in the sense of algebra. Notwithstanding this, it is still as true today as it ever was that intuitive understanding plays a major role in geometry. And such concrete intuition is of great value not only for the research worker, but also for anyone who wishes to study and appreciate the results of research in geometry”. The following hypothesis is based on such intuitive thinking along with the study of research matter in the said field.

It can be observed that the two-dimensional Flatlander travelling on a Mobius has its organs reversed once it reaches the starting point as shown in Fig. 21. In 1999’s Magazine Fantasy and Science Fiction, Paul Doherty and Pat Murphy (Doherty and Murphy 1999) discuss that if the Mobius strip is one-sided as it has been proven to be, and if a hole was punched through such a strip, where does the hole go? It may be thought that the hole goes from one side of the strip to the other but the strip is one-sided making it a mystery that these two researchers have solved in their article. According to their hypothesis, the hole goes from one location on the one-sided strip to another location on the one-sided strip. This is explained by the

Fig. 21 A Flatlander travelling on the Mobius (Kanetkar 2013)



example of a two-dimensional Flatlander for whom this hole could provide a startling shortcut to a distant location (a spot that the Flatlander would otherwise have to tread a long path to reach) (Doherty and Murphy 1999). This shortcut would go through the third dimension, something the two-dimensional Flatlander would have a tough time visualizing. So this proves that if a two-dimensional creature can be given a shortcut through the third dimension, then surely there exists a way to provide a three-dimensional creature a shortcut through the fourth dimension.

Kip Thorne in his book *Black Holes and Time Warps—Einstein’s Outrageous Legacy*, explored the science fictional possibilities of the wormhole, a hypothetical shortcut for travel between distant points in the Universe (ibid). Like the hole in the Mobius strip, a wormhole connects two points by taking a shortcut through another dimension (ibid). Thorne postulates something called “exotic matter” that holds the wormhole open by pushing its walls apart gravitationally (ibid). He indicates that such exotic matter does indeed theoretically exist: Stephen Hawking’s discoveries related to black holes suggest that such matter may exist near a black hole’s event horizon (ibid). Upon connecting this to that hole through the Mobius strip: A Flatlander mathematician or theoretical physicist might theorize that such a thing was possible, and be accused of indulging in science fiction. For the Flatlander, that hole was punched by some unimaginable entity existing in another dimension. From our point of view as three-dimensional creatures, wormholes are similar (ibid).

Since the existing patterning methods create a three-dimensional garment using two axes, then can it be said that a method that uses three axes would result in a four-dimensional garment? These observations further establish that the Planar Flux can be considered a four-dimensional clothing technique.

14 Conclusion

Sustainable fashion is no longer and oxymoron. The above literature hints that while fast fashion brands continue to make profits, consumers are slowly becoming more aware of the reality of the fast fashion system. The example models of sustainability mentioned in this chapter focus on a generic ideology of 'slow fashion'. While these may be successful innovations and improvements within design and prove to be important conversation starters, they come from small-scale production that has limited impact on a global scale. Risk-taking design is seldom seen as a prospective large-scale business model. This chapter effectively depicts the benefits of laying out a practical strategy for a sustainable future by assessing and determining short-term and long-term goals for the same.

Consumers need to be told more about their clothes, its origins, processes and people who made them. Involving the consumer who is a vital stakeholder for the success of a sustainable fashion environment, requires a keen understanding of their perception of sustainable fashion. Given the current economic situation, most consumers are still unwilling to pay higher prices for sustainable products. They remain vested in fast fashion not because they are oblivious to the need for sustainability but more so because cost still remains a primary purchase driver. Therefore, instead of proposing the complete abandonment of fast fashion which would seem farfetched in the current scenario, injecting the serum of innovation into the current system could instill a renewed appreciation for novel ideas and slowly cause a shift in consumption habits. It is posited that an approach to reduce consumption, cutting and construction can help in the redistribution of time that can then be allotted for design innovation. Slow fashion is already making its way into the fashion scene. However, as an immediate solution slow fashion must co-exist alongside a more innovative fast fashion system for any real change to materialize.

Reassessment of the design process and the designer itself have been stressed upon. A more integrated working model that merges the roles of designer and maker is stipulated, thereby focusing on the need for patternmaking to be handled with a creative outlook. This chapter posits a two-part solution for a sustainable model that focuses on a design-led framework. Part one discusses education as a pathway to increase awareness among students, designers and companies. The role of education as a medium of communication, not limited only to universities and schools, is substantiated. Risk and uncertainty are driving factors for innovation (McQuillan 2012) and should be inculcated in the education model. Collaborative design has an important role to play for true change to come about. Co-creation adds a new sense of value to the product and promotes new ways of thinking about making through the act of making (McQuillan et al. 2013). 'Value addition' requires a renewed status to beget fresh meanings associated with products. While physical ornamentation enhances the aesthetic appeal of the product, additional attributes like innovation, co-creation, handmade, after sales service, etc. can enhance the sensorial qualities of a product. Such garments may be viewed as both economic and emotional investments (Aakko and Sivonen-Koskennurmi 2013). In this chapter we see the importance of

brands and apparel companies taking responsibility to create better, meaningful and sustainable products that not only help educating the mass consumers but also have a positive impact in educating/training their own employees as well.

The second part of the proposed model endorses the use of topology in the design process for improved sustainable designs. The examples cited are convincing in their final outcomes although these were not manufactured at a large scale. A hybrid cutting technique called Planar Flux that amalgamates the fundamentals of Subtraction Cutting along with the concept of a Mobius strip (an intriguing topological concept) is introduced. This technique focuses on the movement of the pattern through different planes for a remarkable higher sustainability index compared to its conventional counterparts. Recent literature hints at the need for a positive change in the sustainable development of the fashion industry that are beyond the supply chain, to other areas such as business innovation, sustainable consumption, and consumer engagement (Kozłowski et al. 2015), all of which is addressed by Planar Flux. Planar Flux follows an alternate proposed model of the design process that focuses on reducing Consumption, Cutting and Construction and not only has the capacity of large-scale production but is also sustainable in all the three aspects namely social, environmental and commercial. It can thus be concluded that Planar Flux is a method that intelligently strikes a balance between innovation, ethical fashion and aesthetically appealing/engaging design.

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