ZERO WASTE: EXPLORING ALTERNATIVES THROUGH FOLDING

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ABSTRACT

The paper discusses a new approach to eliminate Cut and Sew Waste (CSW), at the construction stage of garment-making called DPDC, a synthesis of designing, pattern-making, draping and cutting & incorporating zero-waste techniques using one-piece fabric. The objective is to create an open source of templates for the design community to integrate in their pattern-making frameworks. Taking reference from step-by-step origami, using only a rectangle or a square paper as the starting point, the translation of folds from paper onto fabric led to interesting discoveries in terms of construction and wearability. Since the construction of the garment follows a very simplistic approach, it moulds in accordance with the wearer's body. In addition to effective fabric management, this technique offers production and financial incentives in terms of fabric utilisation.

Key Words: Zero Waste, Folding, One-piece fabric, Template

INTRODUCTION

Producing fashion and textiles involves some of the longest and most complicated industrial chains in the manufacturing industry. The conversion of raw textile fibre to finished fabric and finished product draws on labour, energy, water and other resources and cumulatively makes for a high-impact sector (Fletcher 2014, p. 51). As was recently stated in Pulse of the Fashion Industry Report 2018, the fashion industry is not the second most polluter in the world, but the fifth most, falling after electricity and heat, agriculture, road transportation, and oil and gas production and equal to livestock. The current waste stream from the fashion industry is the result of an energy intensive complex linear supply chain that was shaped over 150 years ago during the Industrial Revolution. The system created a one-way track for goods, which the World Economic Forum refers to as the 'take, make and waste' model (Whitty, 2015, p. 620). All the stages in the supply chain (See Figure 1) produce waste in one form or the other and in varying quantities.

[Figure 1] The linear system of fashion (Whitty, 2015, p. 620).

A fundamental shift is required from a view of the economy as a linear system where we 'take, make, waste', in which over 90% of the resources taken out of the ground today become waste within only three months (Chapman, 2005, p. 8), to a cyclical one where resource circle around the economy becoming source material for new goods (Fletcher, 2014, p. 127).

The textile waste is created in two broad categories: Pre-consumer waste and post-consumer waste. While the latter is mainly concerned with the clothing waste created by consumers, after it crosses the use-phase of its life-cycle and can be controlled very little by the designer, the pre-consumer waste that involves the waste generated during the construction phase of a garment, termed cut and sew waste (CSW), is where the designer can intervene and take control. This waste accounts for an average of 15% of fabric waste and as studies report, the world now consumes about 80 billion new pieces of clothing every year (Ross & Morgan, 2016), this 15% is of a grave concern.

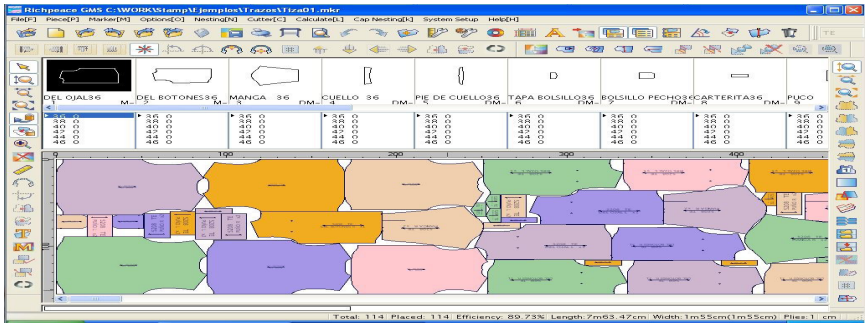
My research is aimed at eliminating this 15%. Instead of thinking how to use the waste generated, why not to avoid generating it in the first place. Is it possible to make garments without any waste? How can designers adopt this model in a more simplified manner without compromising on aesthetics? Is it possible to scale up this zero waste model to mass-manufacturing? This research paper aims at how the pre-consumer fabric waste can be brought down to zero during the designing, cutting and sewing phase of clothing manufacture.

15 PERCENT TO ZERO

The current way in which garments are being made in the fashion industry is using up resources in an inefficient way. The general process from design to production follows: design, pattern making, construction, and production. The separation and hierarchy of these processes has led to a cut and sew fashion system that results on an average of only 85% of effective textile use, leaving the other 15% on the cutting-room floor. These are generally termed as 'off-cuts', and can vary between 10-20% of fabric waste, depending on the garment design (Rissanen, 2008).

Between the initial conception by the fashion designer and a retail store, a mass-produced garment passes through several steps. The pattern cutter makes a pattern (on paper or computer) based on the designer's sketch and the pattern guides the cutter in cutting fabric (See Figure 2). Before the cutting of multiple garments in production, the marker-maker creates a marker (on paper or computer), which contains all the pieces of all the sizes to be cut. In response to the statement made by Rissanen (2013) "the responsibility for this wastage belongs with manufacturer, which is constrained by what has already been designed and pattern cut", it can be inferred that the actual ownership of fabric wastage lies with the people involved at the designing stage.

Why is it that even the most precise marking-making technique in patterns cannot utilise the complete fabric?



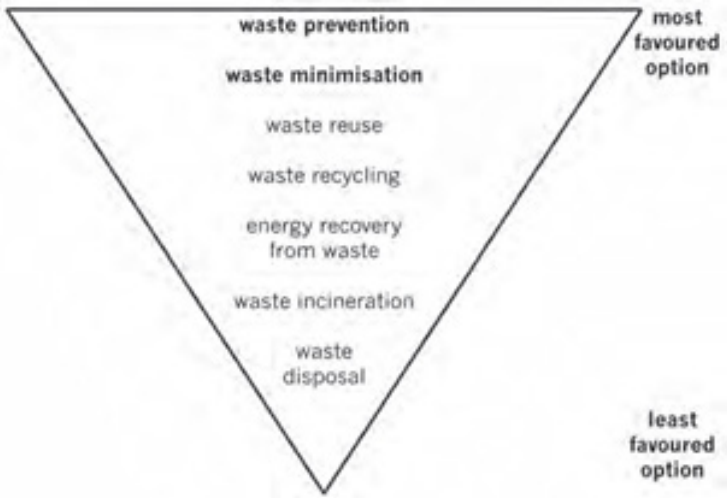
[Figure 2] Marker -making software. Retrieved from https://www.brstudio.com/news/richpeace-garment-cad-marker-system-gms-dongles-emulators.html

The reason is the irregular shape of the pattern pieces that makes them impossible to interlock perfectly to be able to use complete length and width of the fabric. The curves as seen on the pattern pieces are there because the garment has to fit along the body contours. When these curvilinear pattern pieces are placed together, the white/negative areas (See Figure 2) contribute to 10-15% fabric wastage and in mass-production cutting, dozens or hundreds of layers of fabric may be laid out on the cutting table, resulting in layers of this fabric waste percentage.

Fabric wastage is not just a waste of material, but it means wasting all resources, such as fibres, dyes, chemicals as well as water and energy that are used in producing the raw fabric. All fabrics embody the time and efforts of various people from fibre extraction to spinning to textile design and weaving and knitting the fabric; wasting a portion of fabric is also a waste of the embodied contribution of those people (Rissanen, 2013). Granted, the leftover fabric can be utilised in other products or as scraps, but it can be argued that this is not a sufficient way to manage the fabric (Aakko & Niinimaki, 2013a, p. 70). Current practices of getting rid of fabric waste include recycling, sending it to the landfill or incineration for energy production or using the scraps for patchwork, as stuffing material or down-cycled by shredding and tearing to make yarn used to make shoddy (Fabric made from recycled fabric waste at places like the recycling factory at Panipat, India (Gupta & Berardi, 2016)). Fletcher (2014) notes the largest problem posed for recycling is the sheer diversity of fabrics: synthetic and natural fibres are often blended into one fabric, and sorting fabric waste by fibre type and colour can pose a huge problem. Mechanical recycling also shortens fibres, resulting in lower quality yarns and fabric (Rissanen, 2013). When the fabric waste is not recycled, it is sent to the landfill or is incinerated. In the former case, fabric decomposition results in release of toxic chemicals and gases like methane and ammonia (Fletcher 2014) while in the latter, energy recovery is one of the reasons for incineration for energy production. At times, the waste is not incinerated for generation of energy, but the aim is to reduce the volume of waste going to landfill. When there is such an enormous investment of resources embodied in the fabric, why waste fabric?

ZWPC (ZERO WASTE PATTERN CUTTING)

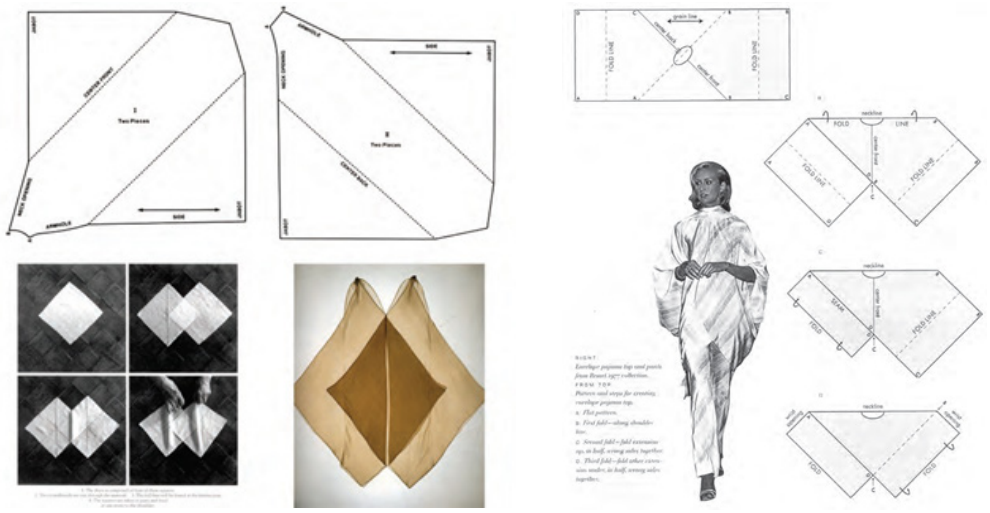
Zero waste fashion design is a tool for eliminating fabric waste and increasing the efficiency of fabric use in garment production. As the terms defines, a zero waste garment is designed and pattern cut in such a way that results in no off-cut waste being generated. Such a garment focuses on the top of the pyramid (waste prevention) as depicted in the waste management hierarchy graph (See Figure 3). Zero Waste Pattern Cutting (ZWPC) method integrates the processes of pattern making and designing. This simultaneous process enables the compete usage of the fabric: design decisions can be made during an evolving process of pattern making guided by the aim of zero fabric waste (Aakko & Niinimaki, 2013b, p. 6). One is seeing the garment evolve instead of visualising it or sketching it on paper. The process becomes more intuitive and generates more creative design options.



[Figure 3] Waste management hierarchy, adapted from White, Franke & Hindle (1999, p. 20)

Zero waste as a concept isn't a new phenomenon. Today, the term suggests a focus on avoiding waste, whereas earlier the main concern was to fully utilise expensive fabrics. Throughout history, various cultures have produced clothes in a way that wasted little or no fabric, be it the Greek and Roman drapes, the Japanese kimono, the Scottish kilt or the Indian drapes (sari, mundu, mekhala, gamcha, lungi, etc.). Design elements often included gussets or gores, minimal arm shaping, rectangular sleeves or pants, and people engineered garment pieces to match the available fabric's length and width. In modern Europe, the Parisian couturier Madeleine Vionnet incorporated zero waste in some of her creations, such as a dress made out of four squares (See Figure 5). Historical and contemporary examples of such designing show that it is possible to design without creating fabric waste, but the rarity of the contemporary examples implies that designers are still hesitant to adopt zero waste approach in their practices.

[Figure 4] Envelope top by Halston, 1977 (Gross & Rottman, 1999, p. 118



[Figure 5] Dress by Madeleine Vionnet (1919) from Kirke (1998) and Demornex (1991) square dress, p. 51

DPDC : DESIGNING, PATTERN-MAKING, DRAPING AND CUTTING

In a general fashion industry practice, a pattern is cut for a garment based on a sketched idea. When a fashion designer is sketching a garment, the design of the garment is more of a consideration than the shapes of the pattern pieces or the width of the fabric. The main aim of the sampling or production unit is to realise the sketched idea in three-dimensional form. Rissanen (2013) said "the key impediment to zero-waste fashion design is the separation of roles of fashion design and pattern cutting". This separation (See Figure 6) is the main reason that distances fashion design from issues it could address, such as fabric waste. People involved in the garment-making process work at different physical locations, at times separated by continents. Even in an independent designer's studio, the tailoring unit is segregated from the design unit, the interactions happening at different floors/units.

[Figure 6] Verticals in a typical design studio

DPDC, a synthesis of designing, pattern-making, draping and cutting, incorporating zero-waste techniques,

using one-piece fabric, is an approach that challenges the predominant roles and relationships between and among designer, pattern-maker, cutter, etc, instead of them working in isolation. 'Space Between'(Whitty, 2015), a model of social innovation for fashion, makes a strong assertion for the potential of working collaboratively in a multidimensional capacity. It encourages a shift in industry practices whilst setting up new opportunities for designers, producers, and new participants (Whitty, p. 625).

DPDC takes into consideration a form of design activism called participatory design or co-design and the potential of designing together to foster a more connected and active engagement with fashion and textiles. According to Ehrenfeld (2008), "Participatory design involves a shift in emphasis away from control; a change in the distribution of power, where systems of production and ideas about design, manufacture, work and outcomes alter. A broad distribution of fashion 'power' would foster skills, pieces, relationships and experiences that allow us become better engaged with ourselves, each other and the material world". DPDC aims for equal participation by all the people involved in the process especially, the pattern-makers, to be working closely with the designer, merchandiser, the cutter and the tailor.

Current ZWPC approach looks at how zero waste garments can be made through intelligent pattern-making and designing techniques. In addition to this, DPDC looks at the approach of cutting and draping, including the roles of designer and merchandiser as well. The whole process, is like a narrative getting formed with the transformation of a 2D into a 3D form. It is a form of discovery. Zero waste design practitioner, Mills, draped each of her garments instead of starting with the paper pattern as she preferred to allow 'the fabric to show her the way', instead

of her 'forcing the fabric to fit the pattern'. Calderin (2009, p.171) explains "Taking the fabric to the dress form is a good way to gauge how the fabric breaks, fold, and drapes. It also provides a better sense of body and bulk of a fabric, affecting decisions about finishing details" (Townsend & Mills, 2013, p. 10). One is constantly moving back and forth from the pattern-making/cutting table to the dress form, making alternating decisions since at times some decisions that cannot be taken on the table (e.g. how the garment falls/ movement aspects. openings, etc.) can very easily be taken on the dress form.

DPDC is about breaking the rules of pattern-making and questioning the set definitions. Unlike the conventional process of pattern-making where the final look is generally predictable before the cutting process is finished, it is the intuition and creativity that guides the process. This practice-based approach allows people involved in the process to take on different roles; blurring the hierarchical roles: the pattern-maker become the designer, the designer becomes the cutter the cutter is the draper, so on and so forth.

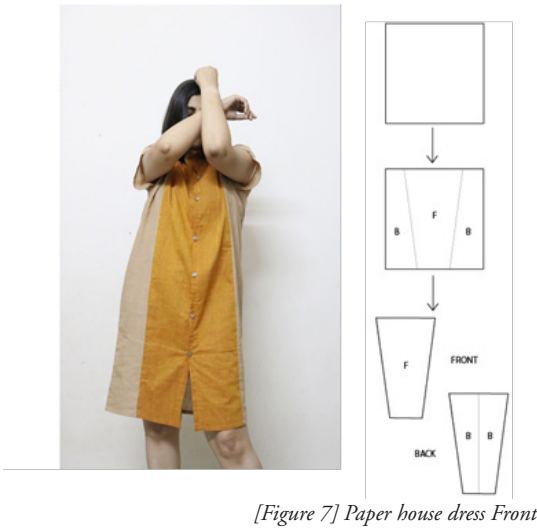
Practicing DPDC approach involves a lot of uncertainty. McQuillan (2009) sees a creative advantage in uncertainty; "I realised that uncertainty can be a great innovator and that as long as you have a destination in mind, you don't really need to know how you are going to get there… the process of risk and uncertainty and subsequent sensitive reaction to this can lead to unexpected positive outcomes that respond sensitively to material, from, and environment. It begins by greeting the raw materials of garment production with integrity". Although DPDC is about breaking rules, it also means one is thorough with one's research in sustainable design and is aware of existing and new-age industry practices. "The more elements of the proposed theoretical model are combined into a designer's work, the more it would potentially enhance the practice of sustainable fashion design" (Aakko & Niinimäki, 2013b, p. 5).

PERSONAL EXPERIMENTS

Initiating the practice with step-by step origami, taking reference from 'Secrets of Origami' (Harbin, 1997), starting with a square-sized piece of paper and creating folds, it was a curious and an inquisitive process as to how the folds on paper would translate onto fabric in the form of a garment. The translation lead to interesting discoveries in terms of construction and wearability. Although one of the initial challenges in this approach was the way folds on fabric were behaving differently than they do on paper. But this was an interesting point of discovery. Some of the folds were tucked here and there or at times draped at certain areas, a piece cut and adjusted elsewhere or just made to fall naturally. This simultaneous process of working on the table and taking the garment on the dress form and back and forth, is what DPDC approach entails. When a half-folded fabric was put onto the dress form, the folds could be draped around the body in interesting ways, or pieces were cut and accommodated at another part of the drape, and any piece cut from the square piece was accommodated as a pocket, layer or just as a reinforcement. Thus, in addition to using a whole piece of fabric and not creating waste the garment is also designed for endurance (Aakko & Niinimaki, 2013b, p. 7).

NOT ALL WASTE IS WASTE

Improving one aspect towards a better fashion system model is not enough. One needs to look at the system holistically, in order to address multiple issues at the same time. Strasser said, "When someone deems a material entity undesirable or unnecessary, it becomes waste" (1999, p. 5). One of the main goals of DPDC is to use waste as fabric source instead of virgin material. The aim is to arrive at a square or a rectangular shape achieved through patch-working waste (sources of which could be end-of-roll waste, cut and sew waste, etc). One of the techniques for patch working that has been used is pojagi: a traditional Korean wrapping cloth (See Figure 8). In my practice, any rectangular or square waste generated was not considered waste. While majority of the shapes in cut and sew waste



[Figure 7] Paper house dress Front-back dress

[Figure 8] Pojagi sample

are curvilinear and difficult to patch together, contrary to this, the rectangular or circular waste can be used to make a different garment without any further wastage being involved, since the off-cuts can fit well as in a jigsaw and for that matter even triangular waste can also fit well. Thereby, not all waste can be rendered as waste in its true

[Figure 9] Paper house dress *[Figure 10] Slash and arrange dress*

When it came to utilising and arranging fabric around design, it offered a lot of possibilities. Some of the fabrics wre engineered around the zero waste design (See Figure 10). The garment can be worn front-back thereby offering two different possibilities to the wearer: plain front or button-down front (See Figure 7). So there were possibilities of multiple variable designs within one cut of cloth. The approach also takes into consideration fabrics and aesthetics, opening, functionality etc and nothing is known beforehand on paper (unlike how the design system usually operates). The entire decision making is happening while the fabric is being cut, stitched, draped, finished etc aiming for more interconnectedness in the whole fashion system.

The above personal design experiments are scalable and can form an open source design which is built on the premise that people have skills and are willing to share them and can successfully collaborate on large-scale projects without being controlled by markets or management. It offers the prospect of a more inclusive and participatory model for fashion and textiles. In the case of DPDC approach, individual designers as well as big retail companies can use these designs, incorporating their aesthetics alongside.

The width of the fabric is crucial for the design process because it imposes limits on the patterns (Aakko & Niinimäki, 2013b, p. 8). It was analysed that the garments made through the DPDC approach are fabric width dependent (majorly since the fabric is being designed through pojagi or bigger patchworks, the width is also in control giving flexibility in terms of the many sizes that can be accommodated. The width of the fabric will define the size of the garment. It becomes the definition of size for a garment. The garments are labelled as fabric widths, giving the consumer an insight into how the garment came into being. The longevity of any garment is also affected by how interested the consumers are in the story/process behind their clothes; in this case, how the garment design was based on an origami shape. Once the garment has been worn completely, the individual pieces can be put back together, since they were all the part of the same garment, and can be brought back to the original square shape. First Son (McQuillan, 2005) explored the potential of dresses made from a single piece of cloth that could be returned back to that single piece of cloth. They transformed from 2D to 3D and back again.

Another advantage of this technique, in addition that the garment can be worn in multiple ways, is that it can be worn by different body types as well. On a particular body type, the same style in different widths would drape differently. The wearer, in essence, is giving a certain character to the garments, and is independent of the size the wearer chooses to buy.

CONCLUSION

The way in which the current fashion system is operating needs to be altered at a fundamental level. As Fletcher (2014) stated, a profound shift in perspective is required from accepting waste as an inevitable by-product of the sector to a future where the provision of fashion and textiles and their consumption is connected differently (Fletcher, 2014, p. 126). It is better to avoid waste than to fill the planet with things made from it. Zero waste is a promising waste reduction technique to be adopted by an independent designer working in his/her studio as well as the people involved in the retail sector. It can change industry's attitudes towards better resource use. DPDC, as an approach, if further investigated and researched can lead to significant reductions in cut and sew waste. With global production now exceeding 100 billion garments a year (Cooper, 2018), even if few brands can take a constructive step in this direction, substantial waste reduction can happen.

As Mark Liu said, "[To] sit back and be part of the system is not good enough. We have to try to invent new ideas and be continually researching" (Black, 2013, p.248).

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