



# Zero Waste Fashion: Exploring Zero-Waste Pattern Cutting to Eliminate Fabric Waste in the Garment Manufacturing Industry

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## Abstract

The realm of fashion is currently undergoing a transformative shift driven by the burgeoning embrace of sustainability ideals. Consumers are now drawing inspiration from notions such as up-cycling, circular design, and the ethos of slow fashion. Consequently, designers find themselves compelled to mitigate the carbon footprint that the fashion industry has historically left in its wake. While commendable efforts have been focused on curbing waste generated during the manufacturing phase of garments, a notable gap exists in addressing wastage during the design and cutting stages. Despite a manufacturing practice like the long-standing “Cut and Sew Method,” which boasts approximately 85 percent fabric consumption efficiency owing to its traditional adherence spanning over five centuries, a significant 15 percent of fabric wastage persists within the confines of the cutting room itself. This regrettable wastage is intricately linked with a consequential “ecological footprint.” In contrast to this age-old norm, unconventional and avant-garde pattern-making approaches, including the subtraction method, geo-cut method, and A-POC, have gained considerable traction. Paradoxically, the concept of zero-waste pattern cutting (ZWPC) has not garnered equivalent recognition or dissemination. A comprehensive comprehension of the relatively restricted acceptance of ZWPC necessitates a meticulous exploration of the concept’s intricacies, as well as its advantages and disadvantages. To unravel this, an exhaustive review encompassing research endeavours and projects undertaken by both seasoned experts and emerging practitioners in the realm of ZWPC was conducted. This in depth review reveals that the adoption of the ZWPC paradigm presents limited challenges, positioning it as a viable approach with extensive applicability. This approach holds the potential to rectify the vexing issues associated with the disposal, reutilization, or recycling of fabric wastage, thereby addressing a critical concern in the fashion and textile domain.

**Keywords:** Pattern making; Sustainable fashion; Textile waste; Zero – waste pattern cutting

## Introduction

Within the fashion cycle, textile waste emerges either before or after consumer use. In the pre-consumer stage, waste originates from fibers, yarns, fabrics, and garments during manufacturing. Post-consumer waste includes garments and discarded household items. While significant efforts are being directed towards minimizing, recycling, and reusing waste at all stages, there’s a notable oversight concerning pre-consumer textile waste generated

during design and cutting processes [1]. Approximately 15 percent of fabric is squandered as off-cuts during the pattern cutting phase in garment manufacturing, leading to wastage not only of the fabric itself but also of associated natural and human resources. This includes the resources invested in fabric manufacturing.

Consequently, the optimal approach is to target the root of the issue by maximizing fabric utilization and minimizing waste.

Adopting a zero-waste design strategy not only reduces fabric waste but also alleviates strain on other resources [2]. Typically, a substantial portion, ranging from 15 to 25 percent, of the fabric required for garment construction becomes wastage due to well-established and intricate norms in garment design, pattern cutting, and production methods. For adult outerwear, fabric wastage varies from 10 to 20 percent, while around 10 percent wastage

occurs for trousers. However, higher wastage percentages are observed for blouses, jackets, and underwear. The constraints of traditional pattern cutting methods make achieving 100 percent fabric utilization unfeasible, primarily due to the irregular shapes of pattern pieces [1] (Figure 1). This variation in wastage (ranging from 10 to over 20 percent) hinges on several factors, including:



**Figure 1:** A marker plan with 4 graded size patterns showing efficiency of 86.89% [3].

- Garment style (pattern piece count, size, and shape in relation to fabric width);
- Quantity of garment sizes within a single marker; and
- Marker-maker expertise, whether manual or computer-aided [3].

Upon careful examination of potential factors contributing to fabric wastage in fashion garment construction, a significant revelation emerged: the consideration of fabric waste is currently limited to the marker planning and production stages. Unfortunately, by the time this stage is reached, the garment design is already fixed and unalterable. To effectively address wastage, this scrutiny underscores the necessity of regarding fabric waste at an even earlier juncture, within the very design process itself. In order to truly mitigate wastage, it becomes imperative to incorporate fabric waste reduction from the outset and consistently throughout the design and pattern cutting phases. The design of the garment and the subsequent pattern cutting intricately guide the entirety of the manufacturing process [3]. The efficiency of fabric utilization is predominantly within the purview of the marker planner and maker, with some influence from the pattern maker. In the present garment manufacturing landscape, the fabric usage concern is often absent at the fashion designer's level [4]. Designers typically focus on trends and styles, often relegating fabric optimization to a secondary consideration during the conceptualization of a garment

[5]. Even if fabric usage is kept in mind during conceptualization, it usually doesn't hold a central role. During pattern making, the pattern maker may propose alterations to curtail fabric consumption. However, there are limitations to their impact, as visualizing the layout of all pattern pieces along their grain lines across the fabric's dimensions proves challenging. Consequently, when the pattern eventually reaches the marker maker, it operates within the confines of parameters set by the pattern maker and indirectly constrained by the original design vision of the designer [3,4].

This paper serves as a guide to grasp the core principles of Zero-Waste Pattern Cutting (ZWPC) and its origins. It delves into the reasons underlying the hesitance or resistance to adopting ZWPC as a fabric waste reduction method. Additionally, the paper examines the key advantages and constraints associated with ZWPC. In reaching substantial insights, the analysis draws from a comprehensive review of research papers, conference presentations, and empirical studies conducted by diverse designers.

### Conventional Pattern Cutting

Pattern making is far from a mundane task geared solely towards facilitating garment construction. Rather, it embodies an artistic endeavor demanding the utmost creativity and ingenuity. It's not just about practicality; pattern cutting is an intricate art

involving the adept manipulation of two - dimensional fabric to harmonize with the contours of the three - dimensional wearer's body [5] (Figure 2). Pattern cutting serves as a vital intermediary, bridging the realms of design and garment production. One might

liken pattern cutting to the painter's brush for a skilled artist. It entails the transformation of a two-dimensional sketch into a tangible garment that adeptly conforms and moves with the wearer's three-dimensional form. [5,6].

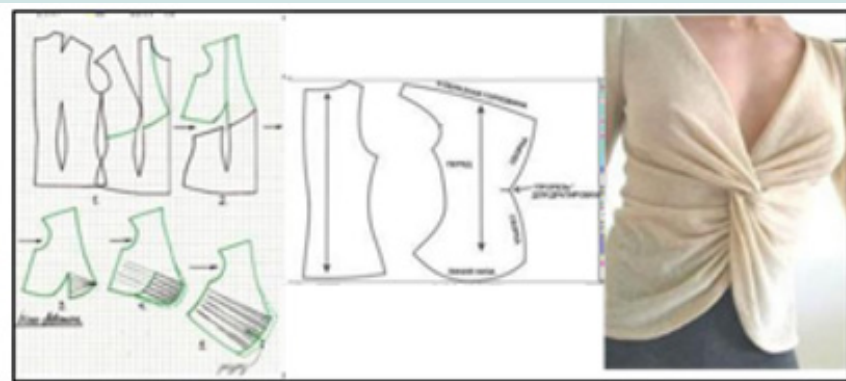


Figure 2: A flat pattern of a top with a twist at centre bust [6].

### Zero-waste design philosophy

The zero-waste design philosophy encompasses a design approach that strives to eradicate fabric waste right from the outset of the conceptualization stage [2]. Pattern cutting assumes a pivotal role within this design framework. Unlike the conventional garment production approach, where fabric wastage during pattern cutting is typically addressed post-design, the zero-waste approach meticulously integrates considerations of fabric waste during the very design phase [4]. The origins of zero-waste design can be traced back to historical practices that aimed to utilize complete fabric pieces, preventing any remnants from entering disposal sites. In today's fashion industry landscape, particularly when sustainability takes precedence, zero-waste pattern cutting (ZWPC) has emerged as a valuable strategy for establishing a sustainable framework within garment manufacturing [7].

### Illustration of Zero-Waste Design Principles in Historical and Ethnic Attire

The zero-waste design philosophy, focused on minimizing fabric wastage during garment creation, isn't a novel idea. Throughout history, numerous clothing pieces demonstrated a deliberate approach to patterns and concepts that reduced fabric waste during the garment construction process. Noteworthy instances of the zero-waste design philosophy can be observed in ethnic costumes and traditional national dresses, where efficient fabric utilization has been practiced [8].

Prominent illustrations of this concept are found in ancient Greek garments such as the himation, chiton, peplos, and analogous attire worn by both genders [9]. Similarly, the sari, a traditional attire for Indian women, exemplifies the principle of zero-waste garment creation. Remarkably, both ancient Greek and contemporary Indian styles share a common foundation: employing an uncut, rectangular piece of fabric. This fabric is skillfully draped and secured on the

body, devoid of any cutting or sewing [4]. Ancient Greek attire and the iconic Indian saree share an additional similarity. Both offer a myriad of possibilities for draping and pinning, enabling versatile and diverse styles of Figure 4. Traditional Indian saree drapes [10] wearing them [4] (Figures 3 & 4). Numerous traditional garments exhibit a notable resemblance to the concept of 'jigsaw Puzzle' styling. A prime illustration is the Japanese kimono, where the garment's pieces are meticulously arranged to utilize the fabric's width and length, akin to a jigsaw puzzle configuration (Figure 5). The uniqueness lies in the fact that no fabric waste is generated during the kimono's cutting process. Any excess fabric is ingeniously employed to enhance the front neck's structure through pleating, rather than being cut and discarded. Likewise, the curvature at the lower end of the sleeve is attained by gently accommodating the excess seam allowance on the inner side [4]. The practice of fully utilizing the complete dimensions of fabric is not a recent development. The zero-waste design approach has historically been applied in Japanese crafting kimonos and weaving Indian saris, ensuring that precious textiles are utilized efficiently. However, this concept lost prominence and relevance following the rise of fashion industrialization and the emergence of fast fashion, which prioritizes the mass production of garments [2].

The period before the Industrial Revolution witnessed textile production and garment creation as not just time-intensive but also heavily reliant on labor. Given the high value placed on fabrics during this era, pre-industrial societies were driven to incorporate every fabric piece into designs, achieving near 100 percent fabric utilization. However, the scenario shifted after the Industrial Revolution, as technological advancements led to faster and more efficient textile production processes. Consequently, fabric wastage ceased to be a pressing concern, with textiles becoming more affordable. In many cases, the cost of fabric waste had negligible repercussions on profit margins [8].



1: Dorian Chiton 2: Chlamys [9].

Figure 3: Ancient Greek costumes.



Figure 4: Traditional Indian saree drapes [10].

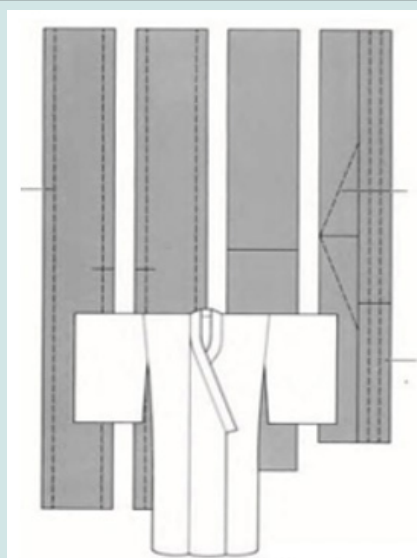


Figure 5: Cut of Kimono [3].

## The Process of Zero-Waste Pattern Cutting

The process of zero-waste pattern cutting typically commences with foundational guidelines, including factors such as the garment type and the fabric's width [2]. Within this approach, garments are fashioned using the pattern cutting technique, with fashion designers operating within the confines of the fabric's width. Consequently, garment design is now shaped by the intricacies of the pattern cutting process, supplanting the conventional sketch as the guiding influence. Consequently, the central focal point of design lies in pattern cutting considerations [11]. A pivotal factor in the zero-waste pattern cutting (ZWPC) method for garment design and construction is the fabric's width. A zero-waste garment cannot be conceived and fabricated without a clear understanding of the textile's width. The fabric's width serves as the foundational canvas upon which the designer crafts a zero-waste garment design [2]. Essential to cultivating a comprehensive grasp of diverse creative pattern cutting techniques is the mastery of fundamental shape and form manipulation and how they interact with the wearer's physique. This profound comprehension serves as a steppingstone toward embracing the logical pathway of the zero-waste pattern cutting (ZWPC) approach for fashion garment design and construction. Garments have evolved beyond elementary shapes, highlighting the significance of understanding the interplay among patterns, fabric, and the contours of the body. Ingeniously

harnessing this equation is of equal importance [12].

A zero-waste pattern that is a square does not, for example, have to be a poncho, as Japanese Fashion Designer Tomoko Nakamichi explains: "I began making patterns for garments, starting with the circle, then the triangle and the square...When you wrap these shapes around you, the excess fabric flares or drapes elegantly...Geometric figures can produce beautiful shapes [12]". Two prevalent methods for crafting garment patterns are by interlocking elements such as pockets, cuffs, collars, gussets, and trims like a jigsaw puzzle, or by directly draping geometric shapes onto form models. Nonetheless, numerous avenues exist for achieving zero-waste garment construction (Figure 6). Unlike the constraints of conventional pattern cutting techniques, zero-waste design does not adhere to fixed rules or guidelines, except for a singular directive: no remnants should be left on the cutting room floor after pattern cutting. This approach serves as a potent tool for combatting the disposal of millions of tons of fabric off-cuts annually [11]. Zero-waste pattern cutting (ZWPC) has rekindled two historical ideologies, harkening back centuries. Firstly, it reasserts the notion that fabric is, in essence, a complete product in its own right. Secondly, it underscores the pivotal role of the pattern cutter within the traditional framework of garment design and manufacturing [12].

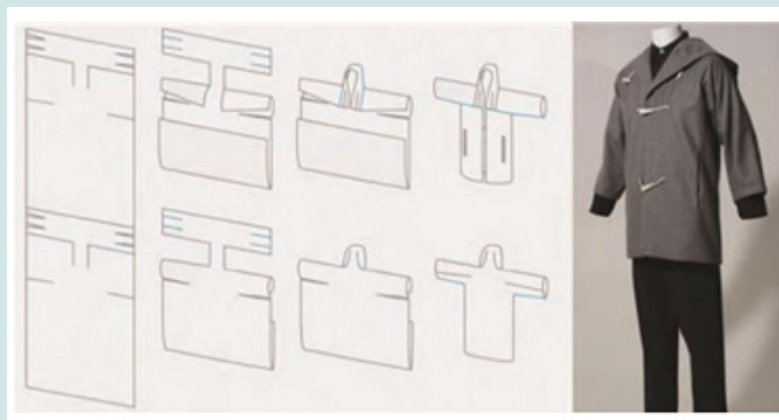


Figure 6: Zero-waste duffel coat by David Telfer (using slash technique) [9].

## Limitations of ZWPC

- a. Designing zero-waste garments through sketching is difficult. [11] A significant majority of fashion designers lack the capacity to prescribe the construction methods for their designed garments. This poses a substantial obstacle, given that a profound understanding of pattern cutting and garment assembly constitutes the essence of the ZWPC process [13].
- b. Moreover, extending the preceding point, a majority of designers (not confined to fashion alone) tend to envision fabrics within a simple two-dimensional structure. They often perceive fabrics existing along a solitary visual plane, which might manifest as a hanging curtain in its simplest manifestation

or be adapted into a three-dimensional shape like a chair cover or dress. Nonetheless, the practice of ZWPC demands a subtler interplay between a two-dimensional pattern and a three-dimensional structure, in contrast to the relatively straightforward nature of conventional fashion design practice where the three-dimensional form predominantly dictates the entirety of the two-dimensional pattern [13].

- c. An essential factor influencing the incorporation of the ZWPC process into the mainstream fashion industry is the clear demarcation of responsibilities between a fashion designer and a pattern cutter within the garment manufacturing process. As mentioned earlier, either these two roles need to be

consolidated within the designer's scope, or there should be a close collaboration between the designer and pattern cutter to harmonize their roles effectively [3].

d. A prevalent critique encountered by the ZWPC process is the perceived reduction of aesthetic control for fashion designers over zero-waste garments [13]. A significant hurdle identified within ZWPC revolves around devising a commercially feasible, inventive, and appealing garment style. Additionally, the garment style must strike a balance between modern chicness and a lack of overt theatricality. This challenge underscores the pivotal role of the cutting method in shaping the garment design [12]. Consumer preferences lean toward garments that exhibit characteristic aesthetics—those deemed classics or currently en vogue [14].

e. ZWPC presents a creative quandary. In order for it to gain widespread recognition as a manufacturing practice, zero-waste garments must be produced at a scale across various sizes. A recent literature review has notably emphasized this concern, yet regrettably, it has not proposed a concrete solution [15].

### Advantages of ZWPC and potential approaches to address its limitations.

a. An economic advantage inherent to the ZWPC process is the increased efficiency in pattern cutting time, attributable to the presence of multiple pattern pieces separated by each cutting line. Traditional designs generally lack numerous shared cut lines, which could otherwise be deemed desirable. Ordinarily, a garment with 20 pattern pieces takes longer to cut than one with 10 pattern pieces. Surprisingly, a zero-waste garment comprising 20 pattern pieces is swifter to cut compared to a conventional counterpart of the same pattern piece count, owing to the presence of shared cut lines [3].

b. The expense linked to fabric waste management and subsequent disposal is substantially curtailed or entirely eliminated [3].

c. ZWPC cannot be subjected to the conventional practice of pattern grading. Adjusting pattern shapes for expansion or contraction is infeasible, given their flush positioning. Unlike traditional grading, which typically involves width adjustments, ZWPC patterns are meticulously laid out across the fabric's width, leaving no room for widthwise modifications. While rotating patterns could permit lengthwise growth, it would alter the pattern pieces' grainline, thereby impacting the drape and overall aesthetic of the garment. An alternative approach proposes the incorporation of lace insertion in ZWPC to achieve size variation. By maintaining consistent pattern shapes and integrating varying lengths and widths of lace, the sizing grading for a garment pattern developed through the ZWPC approach is successfully realized [15].

### Conclusion

While ZWPC holds the potential to revolutionize the fashion design industry and its ecological impact, a limited comprehension

of the interplay between fabrics and form constrains problem-solving approaches. It's crucial to inquire about how technology has historically advanced shape form-making, drawing insights from the works of designers like Issey Miyake and Dai Fujiwara in A-POC (1999 - present). This exploration can shed light on the fundamental reasons behind the deficiency in recognizing the interdependence of fabrics and design. Notably absent from traditional global fashion design education, the concept of ZWPC demands intuitive and creative thinking in both the design process and the garment's final appearance. Thus, proactive teaching strategies should be formulated and enacted to train a new cohort of designers proficient in ZWPC. Finally, ZWPC, closely tied to sustainability, holds the potential to catalyze an innovative partnership between design and cutting teams. This, in turn, could establish a commercially viable production model for the fashion industry.

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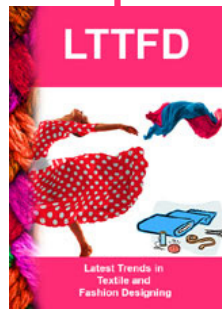
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