Exploring Zero-Waste Pattern Cutting for Transformable Garment Design Process

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Introduction. Textile waste management is a crucial factor that needs to be considered in garment production. According to the U.S. Environmental Protection Agency (2018), textile waste takes up nearly 6% of a landfill, and it is constantly increasing. Zero-waste pattern cutting (ZWPC) eliminates 15-20% of pre-consumer textile waste in the garment design process by using the entire width and predetermined length of fabrics (Rissanen, 2013; Townsend & Mills, 2013). Despite the benefit of ZWPC to reduce the waste, only a few companies attempted ZWPC in their design collection, and it happened to be one-off production (McQuillan, 2019). Thus, a further probe on ZWPC practices is needed to promote its mass production and reduce pre-consumer textile waste.

McQuillan et al. (2018) introduced user-modifiable zero-waste fashion practices involving a transformation in the garment that can be made and modified by users with no fabric waste. User involvements expand the emotional connection between a garment and a wearer, extending the garment's functional life (McQuillan et al., 2018). Transformable garments also contain do-it-yourself and multi-life design stimulating consumers' emotional attachment to their garments (Koo et al., 2014). Both transformable and user-modifiable garments bring sustainability by extending the garment lifecycle because they increase garment usability in actual numbers and years of being worn. While previous studies explored ZWPC design that involves transformation, to our knowledge, it is rare, and the research is still ongoing. Thus, the purpose of this study was to explore ZWPC within the transformable garment design process using a case of simple zero-waste garment pattern making. The specific objectives of this exploratory design research were: (a) to examine ZWPC methodologies in the literature, (b) to explore creating a transformable ZWPC design, and (c) to analyze transformable ZWPC garment design process.

Approach. This case study has taken practice-based design research to explore ZWPC practices for transformable garment design. Previous studies suggest that ZWPC methodologies involve tessellation, jigsaw, embedded jigsaw, multiple cloths, and minimal cut (Carrico & Kim, 2014; McQuillan, 2011). Tessellation refers to putting one identical pattern fitted and repeated all together without any gaps (Carrico & Kim, 2014). A mathematical approach is necessary to shape tessellation patterns since every piece of geometric shape needs to be fit in a fixed fabric shape and width (McQuillan, 2011). In contrast to the tessellation, jigsaw methodology allows shaping a different form of pattern pieces using traditional jigsaw organization to put pattern pieces on the fabric. All edges of patterns are shared and interlocked altogether, allowing no negative space (Carrico & Kim, 2014). In this study, we employed tessellation and jigsaw methodologies in the initial research stage to understand current ZWPC methodologies and

initiate a new transformable design. The final transformable ZWPC design in this case study used 100% organic cotton as the main fabric and recycled dryer sheets for facing.

ZWPC Design Process with Findings. The process of transformable ZWPC design involved pattern development, prototype production, and analysis stages (see Figure 1). Designers must think creatively and reverse the traditional pattern making process because ZWPC practices involve restrictions in fabric use; fabric controls the process, and the final design is neither preconceived nor planned. In the pattern development stage, we chose a square to follow tessellation methodology because it gives a more straightforward calculation since it has a similar shape to a fabric. A calculation was required to trace the existing methodology. The measurement of square units was determined by the fabric width because the squares had to be equally fitted in width. The fabric used in this study was 60" wide, allowing 10 of six-by-six inches squares in a row. A unit of squares was printed on fabric via iron heat transfer to indicate how tessellation was developed in this pattern (see Figure 1). Then, jigsaw methodology was utilized by following an outline of tessellated squares. Matching seams were crucial to fit every edge of shapes, and calculation was employed in this process. Following these methodologies identified the rectangular and H-shaped patterns to use in this study.

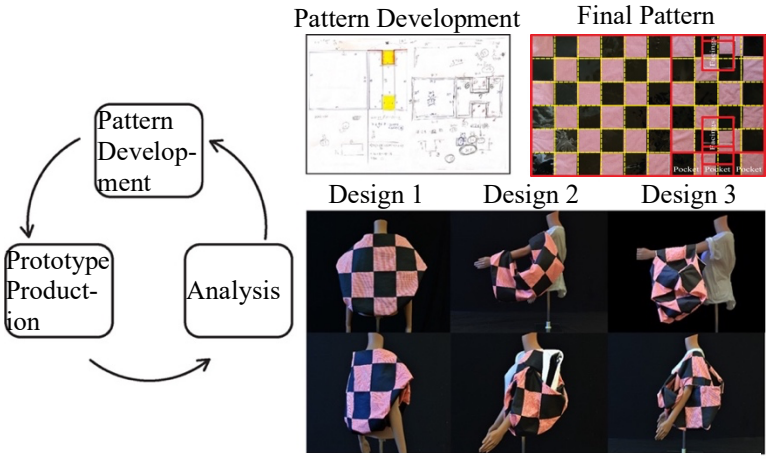

Figure 1. ZWPC for Transformable Garment Design Process

The prototype garment was produced with muslin in the next stage of the design process. The garment was first placed on a dress form, and seams were ripped and draped in various angles to seek garment transformability. The analysis stage involves the evaluation of fit and garment transformability suggesting a potential adjustment of the pattern, which was modified accordingly. This ZWPC design process is nonlinear; the entire process was repeated until final patterns and designs were settled. The final pattern involved one H-shaped and nine rectangular patterns, including four facings and pockets, respectively. The process has established a new transformable ZWPC garment with three design options for use (see Figure 1). The garment can be worn as a jacket and held as a bag in two styles. Two invisible zippers were sewn to seams in the square and the H-shaped patterns. A yard of fabric was used, generating three designs that are transformable anytime based on users' needs. This whole production generated a zero-waste of fabric, demonstrating a sustainable pattern making process.

Conclusion. This case study illustrated a sustainable pattern making process by exploring to create a transformable ZWPC garment. The transformable ZWPC design extends a garment's lifecycle by encouraging consumers' emotional attachment to a garment. Moreover, the product

should be intended to maximize time efficiency to achieve sustainability in design (Anastas & Zimmerman, 2003). During garment production, a simple pattern (e.g., rectangular and H-shaped) would bring time saving in fabric cutting compared to traditional patterns where various angles and curves exist. Thus, a transformable ZWPC garment fosters to implement sustainability practices in the fashion industry through (a) avoiding pre-consumer textile waste, (b) achieving transformability in design to extend a garment lifecycle, and at the same time, (c) showing an aesthetically pleasing design.

This exploratory design research contributes to current literature where a limited study has been explored regarding transformable ZWPC garments. The design process illustrated in this study provides insights for design researchers and industry professionals who are willing to incorporate ZWPC in their design practices. Future research may explore this practice using common fabric widths (e.g., 54" and 72"). Besides, additional fabric usages rather than a yard will bring a room to create garments with an entire top and bottom look. Furthermore, this practice may be integrated with design technology (e.g., laser-cutting) to precisely cut fabric and enhance time efficiency in garment production. Transformable ZWPC practice has a great implication to be explored further, bringing a sustainable future to reduce textile waste.

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