A Foray into Zero-Waste Pattern-Making Procedure in Apparel Design – A Review

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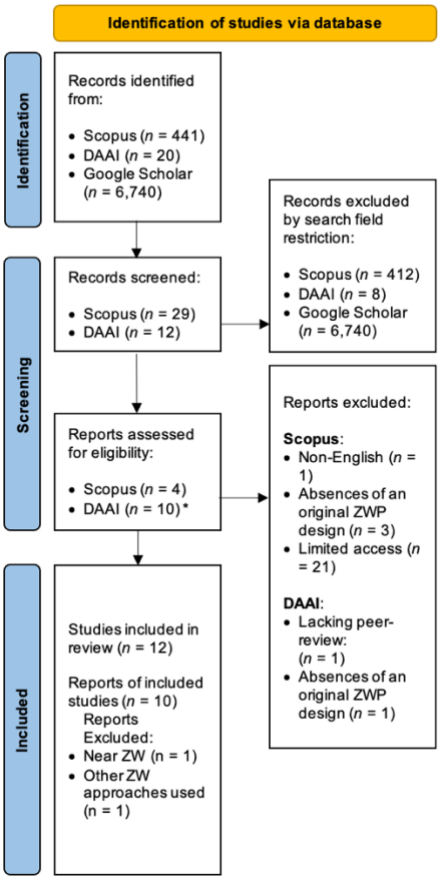
Introduction. Garment production typically results in 10%–20% of fabric scrap waste (Rissanen, 2013). To reduce waste, zero-waste patternmaking (ZWP) endeavors to modify traditional pattern shapes by creatively laying out patterns to maximize the utility of a selected amount of fabric (Niinimäki, 2013). Since ZWP counters traditional methods, it requires a fresh approach to build a garment design, making interested designers hesitant to try this method. One of the ways designers become familiar with ZWP is through observing others' ZWP designs and their design processes, like pattern drafting information (e.g., strategy used, pattern layout) on existing examples that can guide designers in using and applying this method.

Although the existing reviews of ZWP literature (ElShishtawy et al., 2022; McKinney et al., 2020) describe ZWP approaches (e.g., jigsaw, tessellation), little is known about how actual ZWP designers apply such approaches in their practice and what the process looks like. Clear directions for achieving ZWP, specifically about pattern drafting, remain insufficient, hindering the practice's advancement (McKinney et al., 2020). Thus, the purpose of this study is to review ZWP literature to make the pattern drafting strategies and the processes of ZWP more transparent. The following questions guided the review: (1) What kinds of strategies have designers taken during their ZWP development processes? (2) In what ways have designers communicated and described their ZWP design processes? (3) What kinds of obstacles did designers confront during their ZWP processes and how did they overcome the obstacles?

Methods. A systematic review of literature was employed based on the flow chart within the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) as shown in Figure 1. The eligibility criteria were: papers must (1) present original ZWP apparel design, (2) use the ZWP method to achieve zero-waste fashion (i.e., studies employing other zero-waste methods like upcycling were excluded), (3) address the ZWP development process, (4) be published in English, and (5) be peer-reviewed. In November 2023, the terms, apparel, zero-waste, patterning, and their synonyms were searched on three databases: Scopus, Design and Applied Arts Index (DAAI), and Google Scholar. The first screening process relied on an automatic process by altering the search field within the title, abstract, and keywords. Altering the

Figure 1
PRISMA Flow Diagram



Note. * Indicates that two were identical to two papers found in Scopus.

search fields excluded papers from Google Scholar due to the limited search options the database provided. In addition, 21 design proceedings from the ITAA Annual Design Exhibition were eligible and considered, however, only a few examples were shown in this report due to the limited pages of the abstract and reference list.

Results. Ten papers were included in this report (see Figure 1). All articles used practice-based research, and four articles included more than one ZWP approach. The three main ZWP approaches observed were jigsaw/embedded jigsaw (n=6) followed by cut and sew (n=4) and tessellation (n=2). Single instances of transformational reconstruction, multiple cloth, planned chaos, minimal cut, and geo-cut were also observed.

ZWP Design Development Procedures. Designers described that ZWP is made with lots of trial and error (James et al., 2016; Townsend & Mills, 2013). It is a circular and iterative process rather than linear (McQuillan, 2019).

Iteration of 2D and 3D. Designers reflected on the relationship between 2D patterns and 3D forms, and designers in seven papers iteratively went back and forth between 2D and 3D throughout the process. For example, McQuillan (2019) described her design process as an "iterative 3D–2D–2D–2D–3D process" (p. 816). Also, three articles suggested that enabling this iterative process in the industry through teamwork between designers and patternmakers will support ZWP applications (James et al., 2016; Ramkalaon & Sayem, 2021; Saeidi & Wimberley, 2018). *Fitting Techniques to Close the Gap.* Lei and Li (2021) underscored that a main consideration in the transformation between 2D shape and 3D form is to close the gaps between the human body and clothing. To reduce the gap, designers used various fitting techniques, including pleats and darts (Lei & Li, 2021), origami (McQuillan, 2019), gathers (e.g., Bernardoni, 2022b), and folding (e.g., Carrico, 2022). Furthermore, designers considered the material elasticity by either using an elastic band or knit fabric to close the gap (e.g., Bernardoni, 2022a; Carrico & Kim, 2014; Lei & Li, 2021; Ramkalaon & Sayem, 2021; Saeidi & Wimberley, 2018). *Fabric Consideration.* Interestingly, one paper highlighted the importance of fabric selection at the beginning of the design process (James et al., 2016). Changing fabric in the middle of the design process can highly impact the final prototype's drape and require more time to achieve the desired look. *ZWP Design Assessment.* Designers in four articles evaluated their prototypes to ensure their designs were aesthetically and functionally appealing (Carrico et al., 2022; Lei & Li, 2021; Ramkalaon & Sayem, 2021; Saeidi & Wimberley, 2018).

Communicating ZWP Development. Designers are visual communicators; all articles shared supportive images that help readers understand their ZWP processes. These images included pattern layouts, flats, sketches, and prototypes. Color-coded pattern layouts and flats clearly presented the prototype and the approaches used. Likewise, three articles showed their ZWP workflows using a diagram and made the process explicit.

ZWP Design Obstacles. Designers recommended that the ZWP garments need to meet mainstream design demands in terms of garment shape, size, and production (n=5). To overcome the obstacle, designers created ZWP garments intending to serve mainstream demands (Carrico et al., 2022). The time required for ZWP could be a barrier, but technology adoption could be a solution (n=2). Despite the additional time requirement of ZWP, designers were optimistic about the process as it is "essentially [better to] solve the problem of what to do with fabric scraps before they become a real problem" (Saeidi & Wimberley, 2018, p. 252).

Discussion. The review elucidates the ZWP development procedure by explaining what strategies designers have used in their own processes. By making the strategies more explicit, this review provides insights for designers to better comprehend ZWP and apply ZWP in their practices. Being flexible to jump between 2D and 3D and seeing a full picture will support a ZWP. Future study can consider integrating the iteration of 2D and 3D in their a ZWP process. Limitations of this project include potential researcher bias during the literature search procedure along with limited inclusion of publication types.

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