

Making a classic sustainable: Investigation of the impacts of applying zero-waste pattern making and the Carrico strip grading method to a childrenswear denim jacket

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Contextual Review. Either through whole cloth methods or interlocking pattern pieces (Townsend & Mills, 2013), zero waste patternmaking wastes no fabric (Rissanen & McQuillan, 2016). Unfortunately, zero-waste patterns often only create one garment size (McKinney, Cho, Zhang, Eike, & Sanders, 2020). The inability to execute zero-waste patterns in a range of sizes is an obstacle to integrating zero-waste designs into mainstream fashion (Carrico & Kim, 2014). Carrico (2019) developed an inserted fabric strip method to grade zero waste patterns into larger sizes. This solution reduces environmental damage caused by fabric waste during traditional garment manufacturing (Carrico & Kim, 2014) which averages 15% of the fabric (McQuillan & Rissanen, 2011; Townsend & Mills, 2013). Carrico, Dragoo, McKinney, Stannard, Moretz, and Rougeaux-Burnes (2022) demonstrated the strip grading method application for a women's blouse and skirt (Carrico, 2020), athletic wear (Carrico, 2021), evening wear (Stannard, 2021), menswear (Dragoo, 2021), outerwear (Rougeaux-Burnes, 2021) and childrenswear (McKinney, 2021). Childrenswear is an important apparel market with \$9.8 billion in annual revenue (O'Connor, 2019). The significantly different grading proportions between children's and women's sizes (Joseph-Armstrong 2010) presents unique challenges to Carrico's (2019) method. McKinney's (2021) work gives insights into how this method can be applied to children's woven dresses. However, further research is needed to test the applicability of this method to other types of childrenswear garments.

Design Concept. The research problem was to test the narrow fabric sizing method for zero waste patterns (Carrico, 2019; 2020) on a children's denim jacket. The style was selected for its timelessness, ubiquity, and gender neutrality (Leverton, 2015), giving potential findings broad applicability. The research questions were: (1) Can a children's denim jacket pattern be created with zero-waste? (2) Can a zero-waste children's denim jacket pattern be graded to a larger size using fabric strips? and (3) How does the strip grading method impact garment production? Aesthetic Properties and Visual Impact. Denim jacket fabric, golden topstitching thread, jean-style buttons, and style lines reflect classic denim jacket design elements. Matched denim was used for the grading strips to maintain visual continuity between sizes, and topstitching maintained visual proportions between sizes.

Process, Technique, and Execution. A problem-based design research approach (Bye, 2020) was used to address the research questions by producing two denim jackets as first samples. Throughout the process, quantitative and qualitative data were collected and analyzed through memoing, photography, technical sketching, and spreadsheets (<https://youtu.be/IDMc1daThtM>).

To further define the identified research problem, children's denim jackets sold by major retailers (GAP, J Crew, and Old Navy) were reviewed in order to understand essential design elements and sizes offered. Denim jackets had front and back shoulder yokes, six gores on the

front, two front chest pockets with flaps, three gores in the back, a bottom waistband, a collar, forward shoulder seam, and a two-piece set-in sleeve with a cuff. As outerwear garments, they were slightly oversized. A denim jacket incorporating these elements was designed and sketched. Most retailers offered denim jackets in lettered sizes; each covered two numbered sizes such as XS (3/4), S (5/6), and M (6X/7). Thus, the first samples were created in sizes XS and S, with S being the size “graded up” to test the Carrico (2019) technique.

Front Bodice, Back Bodice, and Sleeve sloper patterns were drafted in size XS, then used to create the dartless sloper set. From that, the oversized shirt and sleeve were drafted (Joseph-Armstrong, 2010) and used as the basis for flat patterning the denim jacket pattern (29 pieces) as sketched. The pattern seams were compared with childrenswear grade rule locations (Handford, 2003) to test the feasibility of grading the pattern to a larger size using fabric strips (RQ2). Most grade rules could be accomplished; however, the yoke patterns did not allow for shoulder and neck width grading. Grading sleeve impossibilities included cap-height and arm width increases at the underarm and front notch.

The researcher subsequently attempted to arrange the pattern pieces into a zero-waste layout using the 58” width of the denim fabric (RQ1) while considering how yoke and sleeve pieces could be modified to solve the identified grading problems. All pattern pieces fit the zero-waste layout using 13 inches (.36 yard) of fabric, except for the front and back yokes and sleeves (7 pieces). Altering these patterns to fit into a zero-waste layout and the strip grading method would lose the essential denim jacket elements of front and back yokes and two-piece set-in sleeves. An additional 21.5 inches (.60 yard) was used. Thus, it was concluded that a *partially* zero waste (low waste) children’s denim jacket pattern could be created (RQ1) and that a low-waste children’s denim jacket pattern can *partially* be graded to a larger size using fabric strips (RQ2).

Next, the sloper drafting and patternmaking process was repeated for size S, being careful to maintain the proportions of the design elements. Measurement differences of size XS and S pattern pieces were recorded in a spreadsheet to establish grading strip widths and lengths. An order of sewing operations (56 steps) was written for the size XS, then a second version was written for size S, with grading strips (107 steps). Using the created zero waste marker and order of operations, the pieces were cut and sewn for sizes XS (5 hours) and S (7.7 hours). An additional 391 in.² (6.75 inches / .19 yards) were needed for the strips for size S. Thus, the strip grading method impacted garment production (RQ3) by increasing the steps and time needed; however, it also allowed the use of a low-waste pattern, reducing fabric use and waste. Using strips, only a small amount of fabric was needed to “grade up” to the size S. In future research, the size S jacket should be cut and sewn with the traditional pattern to compare its impact on labor and materials.

Cohesion. The timeless denim jacket style and washable, durable 100% cotton denim are aligned with the sustainability concept of long lifespan garment designs. A long lifespan reduces resource use and keeps garments out of the landfill (Cooper et al., 2013).

Significance, Rationale, and Contribution. This design research quantifies the advantages and limitations of zero-waste pattern design and strip-method grading (Carrico, 2019) for a children’s

denim jacket. Findings have a broad potential impact on sustainable apparel manufacturing, given the style's timelessness, ubiquity, and gender neutrality. Findings may apply to other classic styles with similar pattern shapes. It was demonstrated that uniformly-sized rectilinear pattern pieces and pieces with a single curved or angled edge could easily fit into a zero-waste layout. However, complex shapes such as sleeves and yokes are more difficult to fit and are incompatible with the strip grading method, as they don't have any openings for grading strips. Future research may test the aesthetic acceptability of denim jackets that stray from these original style lines to create zero waste strip-gradable pattern shapes.

Originality and Innovation. This is the first known design research to test zero waste patternmaking and the strip-grading method (Carrico, 2019) on the classic denim jacket style.

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