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Product Development Process for Pre-Consumer Finishing Waste Knit Exploration

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Introduction. During a tour of a northeastern United States textile finishing plant (FP), the lead researcher was given 7.47 lbs. of cotton/bamboo blend jersey knit pre-consumer waste (PCW) material. The waste is the selvage trimming-off of a roll of fabric, a result of the finishing process. Jersey knit's tendency to roll caused this narrow selvage waste to resemble yarn. Typically, this waste is disposed of at FP's expense. Problematically, this waste adds chemicals and textiles into landfills and watersheds. Disposal also is a missed opportunity for FP in the creation of new jobs from the development of products from the waste. The waste, cost of disposal, and new jobs represent the triad of Triple Bottom Line (Hammer & Pivo, 2017). The economy of FP, ecology of the earth and equity of employees may be positively affected by FP's alteration of its choice to dispose of the waste. While PCW may be recycled, that may not be the best sustainable choice for this specific waste; output is lost over time, energy was wasted in the initial creation of the fabric and energy is expended recreating new textiles (Hethorn, 2015). Transforming PCW into consumer products may have a positive impact on the sustainability of the industry. Finding a use for the waste is the first step in promoting that change. Current product development (PD) models, such as in Chun-Sheng Wu and Qiao-Ying Wu's 2011 study, focus on marketing and customer research as the first step of PD. A redesigned PD process model was developed to illustrate a process of exploring uses for PCW in this study.

Study Aim and Research Questions. The purpose of this design concept paper was to share the exploration of the suitability of FP's specific waste textile to be used as yarn. To meet this purpose, the following research questions were developed:

- RQ 1: Can the waste be crocheted?
- RQ 2: What crochet stitches result in pleasing results?
- RQ 3: Can the waste be knit?
- RQ 4: What knit stitches result in pleasing results?
- RQ 5: What is the average output per yard of the waste?
- RQ 6: Does this study result in a redesigned product development process?

Methods. Waste from FP's machine was transported approximately 300 miles in the lead researcher's car in a plastic garbage bag. If the waste were to be collected regularly for PD, a process would need to be added to the finishing machine or process to eliminate the approximately 3 hour untangling step. Following untangling, the waste was rolled into 16 balls, ranging in weight from 29 g (11.5 yds.) to 543 g (203.4 yds.), totaling 3390 g (1261.56 yds.). Weighing and measuring 6 balls of waste, then averaging the grams per yard, allowed the lead researcher to estimate the yardage of the remaining 10 balls. The waste was hand-crocheted into 3 samples and hand-knitted into 8 samples of a variety of stitches, using a 10 mm hook or

needles. The output of each sample that used the entire ball of waste was calculated to determine the square inches per gram of waste. The samples were photographed and the researchers determined the stitches that resulted in aesthetically pleasing samples. The design process was documented and compared to a modification of Wu & Wu's (2011) PD model, see Figure 1.

Findings and Discussion. The 3 crocheted samples created answered RQ1, but only one resulted in an aesthetically pleasing result, only partially supporting RQ 2. Inconsistencies in the PCW width resulted in inconsistent crochet stitches, so the results were not as pleasing as the knit samples. The sample created from a 69 g ball crocheted with a 10mm hook resulted in an output of 0.73 square inches per gram, versus 0.78 for knitting with 10 mm needles (RQ 5). The PCW is suitable for knitting products, supporting RQ 3. Several knit stitches resulted in aesthetically pleasing results including knit, purl, seed, bee, 1x1 rib, 2x2 rib and 3x3 rib; answering RQ4. The researcher's product design process (PDP) differed from Wu & Wu's (2011) see Figure 1. Study, an early step was added and sales and consumer research is performed much later in PD utilizing the PCW. This PD process is centered on efficient use of materials, followed by matching the possible products to interested target markets (RQ 6).



Figure 1. PDP from *Redesigning the Apparel Product Development Process Based on the No-interval Coherently Phased Product Development Model* (Wu & Wu, 2011) redesigned for PD utilizing pre-consumer waste.

Conclusions and Future Research. It is important to recognize that these findings may not generalize to all similarly created FP PCW. The success of using finishing waste as yarn may depend on factors such as: (a) chemical finishes on the fabric, (b) the width of the trimmings/the thickness of the yarn, (c) the length of the waste pieces, and (d) how suitable the yarn is for tying one piece to another. Additionally, the ability to source a consistent supply of the yarn may affect the viability of mass-producing goods of this waste. Because a potential use of the waste was found in this study, it may be possible to positively affect the triple bottom line of FP, if FP recognizes the benefits of making decisions based on promoting the good will of the company's economy, earth's ecology, and employees' equity.

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