Re:Paradox

Han Ah Yoo and Young-A Lee, Auburn University, USA

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Introduction, concept, and context. Plastics, considered as lightweight, cost-effective, durable, and versatile (Geyer et al., 2017; Andrady & Neal, 2009), have been a convenient and useful material used in everyday life. On the other hand, plastics have become a critical environmental concern because of their non-biodegradability (Prasteen et al., 2018; Gebre et al., 2021). Within the textiles sector, upcycling used plastics into new textiles is one of the strategies to minimize plastic waste in landfills (Sezgin & Yalcin-Enis, 2022). Diverse design techniques such as weaving (Afriyie, 2022) and melt spinning (Soekoco et al., 2017) have been utilized for upcycling non-biodegradable plastic waste into woven textiles. However, there is a lack of trials to develop non-woven textiles for wearables by using non-biodegradable plastic bag waste while incorporating innovative design techniques. This design, *Re:Paradox*, was created to challenge how to circle back non-biodegradable plastic bag waste into upcycled non-woven textiles through heat-fusing (Jevšnik et al., 2016) and pleating technique (Huang, 2021).

Aesthetics. The design, *Re:Paradox*, visually reflects both useful and harmful aspects of plastics for humans through the color contrast (light blue vs. black) and the use of double-sided upcycled textiles in different colors (see Figure 1). The shape of the heat-pleated textiles depicts the accumulation of waste from the massive plastic production (Undas et al., 2023). The design features the tangled shape of upcycled textiles on the black mesh outer dress and a distorted print design on the shiny inner dress. These visual expressions showcase the complexity of recycling non-biodegradable plastic waste and the ecological issues caused by such waste. The silhouette widens towards the bottom of the dress to metaphorically portray the growing concern of plastic waste which causes a negative impact to the environment (Geyer et al., 2017). At the same time, the folding property of the upcycled textiles, created through heat-fusing (Jevšnik et al., 2016) and pleating technique (Huang, 2021), portrays an optimal view for reducing non-biodegradable plastic waste through upcycling.

Methods: Process, technique, and execution. This design utilized various design approaches, including CLO 3D simulation, digital textile printing, heat-fusing (Jevšnik et al., 2016), and pleating technique (Huang, 2021), for the upcycled textile development to execute the design intent. For this design, the Cradle to Cradle Apparel Design approach (C2CAD) (Gam et al., 2009), which incorporates the Cradle to Cradle (C2C) model (McDonough & Braungart, 2002), was applied to develop non-woven textiles by upcycling non-biodegradable plastic bag waste.

In Phase 1: Design Ideation, environmental issues occurred during 2000-2023 were researched using various sources, with plastic waste being the most common topic found. During Phase 2: Sample Creation, used non-biodegradable plastic bags, made of polyethylene (PE), were collected from consumers to develop upcycled non-woven textiles by utilizing heat-fusing (Jevšnik et al., 2016) and pleating technique (Huang, 2021) with a household iron temperature set at 400°F. Tensile strength, which is highly relevant to wearables' durability (Akter & Khan, 2015), stiffness, and color combinations (black, light blue, brown, gray, and white) of upcycled textiles were first tested with the sample size of 7" x 7". Through multiple iterations of the textile sample creation and its property evaluation, it was concluded to use 4 layers of light blue and 2 layers of white plastic bags for developing upcycled textiles for this design. Two pleating paper molds with 1” guidelines were crafted and the upcycled textiles with the thickness of .16mm were then pleated between the zig-zag shaped paper molds using heat-pleating technique (Huang, 2021) (see Figure 1). During Phase 3: Solution Development, thin paper molds for pleating were replaced with thicker paper molds for reuse. In Phase 4: Production, the dress design was simulated in CLO 3D to finalize the placement of upcycled textiles on the outer dress and distored print design on the inner dress (see Figure 2). The final print design, created in both Adobe Photoshop and Illustrator, was digitally printed using the MUTOH digital textile printer with eco-friendly biodegradable inks and heat-pressed onto the surface of shiny woven fabric made of 100% polyester at 400°F (see Figure 3). After constructing both outer and inner dresses, the pleated upcycled textiles were draped and attached on the surface of the outer dress made of 100% polyester black mesh fabrics using hand-stitching.

Cohesion. With upcycling non-biodegradable plastic bag waste to the new material, color contrast (light blue vs. black), pleated surface design, and distorted print design, this dress, *Re:Paradox*, visually highlights the critical issue of non-biodegradable plastic waste and portrays the paradox of plastics, which encompasses both negative and positive impacts on humans and other living beings. Simultaneously, the folded surface design and upcycled textiles themselves symbolize a “re-paradox” of plastics by transforming plastic waste into new non-woven textiles for wearables, which is one way of sustainable design practices through heat-fusing (Jevšnik et al., 2016) and pleating technique (Huang, 2021).

Design contribution. The integration of heat-fusing (Jevšnik et al., 2016) and heat-pleating (Huang, 2021) in the creation of this design offers insights into developing a new type of upcycled non-woven textiles using non-biodegradable plastic bag waste. The design employed the C2CAD approach (Gam et al., 2009), ensuring that the design process, including design ideation, material selection, material development and evaluation, and production, well aligns with sustainable design practices during the upcycling process of non-biodegradable plastic bag waste into new textiles. This design offers further insights for textile/apparel designers and manufacturers to use this upcycled textile in the wearable product development. This design focused solely on the technical nutrient component of McDonough & Braungart's (2002) C2C model to transform non-biodegradable plastic waste into new textiles. The design challenge experimented in this design can be further explored by employing the biological nutrient component into the design process to fully close the loop on plastic waste.

Figure 1. Paper molds (left) and pleated upcycled textiles (right)

Figure 2. The 3D prototyping

Figure 3. Digitally printed textiles

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