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Testing methods of remanufacture of pre-consumer textiles in scalable environments

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Abstract: Despite a growing response by multiple stakeholders to address waste issues in the industry, the consumer appetite for newness and the speed and agility of the mass manufacturing system encourages overconsumption Currently, less than 1% of the material used to produce clothing is recycled into new clothing.

As Walter Stahel notes, wasted material is also wasted money, meaning that increasingly industry stakeholders are looking to exploit the potential economic benefit of 'remanufacture' or 'upcycling'. While many micro-businesses are utilising upcycling on a small scale, the impact on the overall resource wastage is minimal.

This paper explores how working in a factory environment can give greater insight into the challenges of working with remanufacture for scale. It will support a greater understanding of the barriers that are impeding the widespread adoption of working with Whole Product (WP) fallout on a production line, while helping to identify the frameworks needed to support methods of WP Remanufacture (WPRem) within the linear commercial environment.

Introduction

To date, many upcycling/remanufacturing strategies have been led by small-scale designers. Understanding how working with WP fallout, (garments that fail quality control and overproduction) within a scaled manufacturing environment is theoretical; According to Kerr and Landry (2017), the next step is to examine systems of scale to have a greater influence in the sector. To comprehend the obstacles to working towards scale, it is crucial to test these concepts in a modern industrial setting.

Stahel (2019) confirms that unless a practical solution is identified within the circular economy, the science will be ignored, underscoring what he describes as an "honest quest for holistic solutions" (Stahel, 2019, p.87). Developing effective frameworks and identify practical solutions will be key in gaining industry and consumer take-up. This fallout field test will identify the current barriers in place that hinder the development of remanufacturing in the textile supply chain. It will support a greater understanding of the shift manufacturers will have to take to embed this "new economy" (Stahel, 2019). The aim is to evidence the possibilities of remanufacturing for Whole Product Remanufacture (WPRem).

Product-level upcycling/remanufacture utilises product already in the system with some academics suggesting that it eliminates the need for a new product (Szaky, 2014), reducing the use of raw materials (material efficiency) and industrial energy for production, ultimately reducing greenhouse gas emissions (Sung et al., 2017). The potential social, economic, and environmental benefits of remanufacture have led some authors to describe this as a triple win (All-Party Parliamentary Sustainable Resource Group 2014; Sinha et al., 2016). This validates the reason to explore remanufacture as a method in fashion.

Using design and remanufacture offers a way for brands to rework WPs consisting of overproduction and A and B-grade garments (fallout). This product was identified in discussions with the manufacturer, with the potential for high-priced remarketing for commercial re-sale (Stahel, 2019).

This paper seeks to produce a run of remanufactured garments utilising WP fallout from the production line while testing out in a scalable setting to understand the potential to scale these techniques for commercial production.

Methodology

The methods in this research are grounded from insights by previous small-scale tests by the researcher (Child, 2021) using making as the primary method to surface insights. This research goes beyond making as a singular activity and uses a bricolage of methods, described as a multi-methodological approach to inquiry (Rogers, 2012; Hall, 2021). This approach looks to draw from both the commercialisation of industry and the intellectual tradition of academia (Fallman, 2008), to seek solutions from both perspectives. Many designers have used this method in textile design, noting this approach allows the flexibility to draw on the methods needed at a particular point, as Hall (2020) states in an active response to the needs of the designer.

The aim of this project was to ensure that the manufacturing facility has agency to feed in, and input in decision-making, to ensure that their expert perspective is considered. LIFE ECAP (2019) highlights how industry co-operation is key, as experts hold knowledge along the supply chain. Working collaboratively combines that knowledge to achieve the best solutions under the current constraints and allows for greater Knowledge Exchange (KE) to take place.

This test focused on t-shirts as a material source. By focusing on a specific garment, the analysis of the method can be developed without a focus on other external design constraints that might arise when mixing garment types. The aim is to utilise as much of the existing products as possible, with little to no virgin material.

The Commercial Facility

Emjay International manufacturing facility in Sri Lanka was selected to carry out the tests. It consists of five factories specialising in different product ranges, with 90% of its market being in Europe (Hameed, 2020).

The garment industry is Sri Lanka's biggest manufacturing sector, mainly producing western fashion (Evans and Park, 2017). Despite this, there are no textile recycling facilities in the country to deal with the waste industry generates (Ibid, p. 8) meaning that high quantities of fallout are finding themselves in waste streams.

Process

Early discussions highlighted that the manufacturing facility had not engaged with this product resource before. McQuillan (2019) states that the lack of information about waste reduction through design interventions in the industry is primarily due to the scarcity of attempts and the opacity of industry (p.200), and this could highlight why manufacturers are unsure how to proceed.

The WP garments, destined for remanufacture followed the existing production line as the virgin garment production. Payne (2015) highlights that production lines have the potential to offer flexibility due to manual automation, suggesting that new systems may not hinder progression. This field test will enable an understanding of whether WPRem can work within the existing production line, offering a step change towards greater circularity in the linear fashion supply chain. If a viable product line can be achieved, then it could make a case for industry uptake.

The first stage was to have discussions with the manufactures and identify WP Fallout on their production line (Figure 1&2). Once this was identified a process of design could take place, utilising the design strategy for remanufacture developed in earlier small-scale tests (Figure 3).

Figure 1: Fallout t-shirts from the manufacturing line (white).

Figure 2: Fallout t-shirts from the manufacturing line (black).

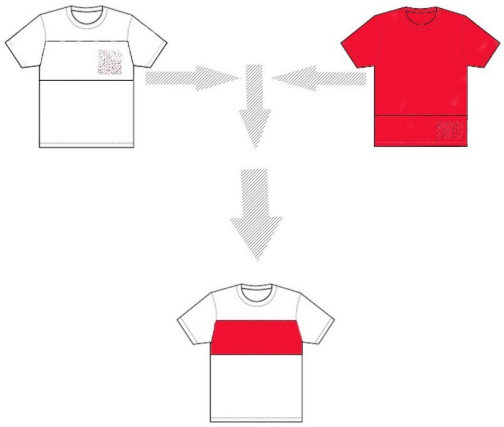

Figure 3: Design strategy for remanufacture.

A technical sheet was developed to outline the proposed designs (Figure 4). This was coupled with a two-way dialogue to reassure the manufacturers that changes could take place. Ensuring that the manufacturing facility had the autonomy to inform design decisions was crucial to the success of this field test as Smyth and Holian (2008) highlight, an insider understands how things work in reality. The designs were kept simple to allow genuine barriers to arise without additional design complications to consider.

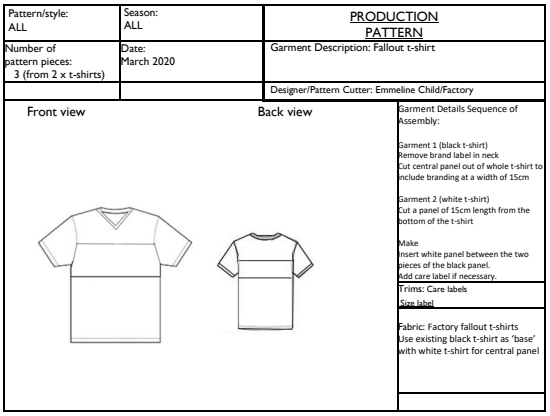

Figure 4: Technical sheet outlining product to remanufacture.

The test took place on location at the manufacturing facility in Sri Lanka, while the designer/researcher was in the UK. When conducting research inside the factory there are many advantages, including the "speed at which breakthroughs can take place" (McQuillan, 2019, p.74). However, in reality, the industry relies on distanced negotiations between the designer and the brand. The project and process were in line with the realities of how the fashion industry operates, whereby agents work in isolation. This gave greater insight into some of the issues and challenges faced when communication is from different perspectives, while helping to gain an understanding of the realities of WPRem in this context. However, drawbacks included nuances and challenges that could be worked through when face-to-face but could not be observed or referenced from a distance. Subtle understandings and communications could be misinterpreted. This reinforces why the industry relies on technical sheets and suggests why rigid boundaries are put in place.

Barriers

Getting the manufacturer to return the fallout product to the linear production line rather than constructing smaller loops outside of the current supply chain was an early obstacle to overcome. This evidences the challenges of working with this product in the existing set up where LP strategies hinder the flexibility of shifts on the production line.

Skills Relied on for Success

Communication, and positive reinforcement throughout the product development stage was vital. Throughout the development of the

product samples, constant communication occurred via WhatsApp chat and email. Communication was also crucial in embedding the philosophy of remanufacture. Initial samples developed by the manufactures were more cost-effective (Figure 5) yet lacked the finished design aesthetic for commercial appeal. This highlighted that flexibility was important to allow methods to surface that would work in the factory context, however it reinforces the need for a designer in the process.

Figure 5: Initial sample remanufactured.

Changing Mindsets

It was difficult to get the manufacturers to think beyond their typical standardised approach. Once accomplished, though, they were open with suggestions. At every stage, two-way discussions took place around the relevant process, while alternative options were explored. This was positive experience, as this relationship allowed this research to flex in response to the findings. Reed *et al.* (2014) reinforce that engagement is key and that, by respecting local knowledge, greater KE can take place. McQuillan highlights that when hierarchies are broken down, greater design success can be achieved (2019, p.155), reinforcing the need to democratise the relationships. Ahmed *et al.* (2022) (Figure 6) outline the structures to ensure good relationships between the two parties, underscoring the need for this to be a two-way knowledge transfer.

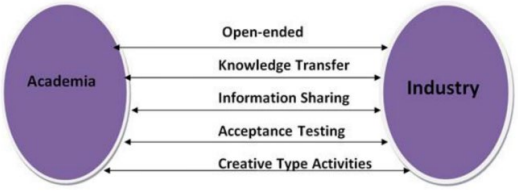

Figure 6: Strategic planning structure for communicating between academia and industry (Ahmed et al., 2022).

The WPRem Products

The developed t-shirts were made using WP factory fallout in their entirety (Figure 7&8). Evidencing proof of concept for this product resource in a factory setting.

Figure 7: Remanufactured t-shirt developed from fallout fashion.

Figure 8: Flexible t-shirt design from fallout fashion.

To capture the decisions made, a Process Diagram for Whole Product Fallout (Figure 9) was developed in response to insights while working with the manufacturing facility, through interviews and the samples developed at each stage. By allowing two-way dialogues to take place, a greater understanding of the resource and its destination routes was achieved, while gaining a handle on the systems in the manufacturer has enabled clarification on textile finishes that could further complement and diversify the range. Clear infographics were developed so that manufacturing facilities and designers could work together to reutilise this product resource.

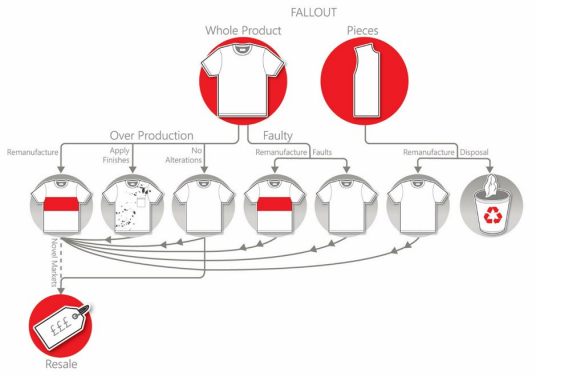

Figure 9: Process diagram for whole product fallout.

Reflection on the Process

The Industry Perspective

Factories measure their productivity by time, and the re-design process more than doubles with the deconstruction process (Hameed, 2020). This makes it challenging to make the process financially viable. Hameed states that products usually take 6-7 minutes to go through the production line, but this remanufacture method takes 20-30 minutes (Ibid). Hameed highlights that this increase in time would be the biggest challenge to overcome and states that manufacturers would need to view remanufacture as a separate business opportunity. If viewed on productivity alone, the remanufacture process does not work. This observation underscores the importance of engaging all parties in this process to highlight barriers outside the design practice of the researcher. A revised pricing structure above the usual tight margins would be needed to make this product line financially viable.

Hameed also observes that he was concerned about the variations and, therefore, quality control of the product range. He states that "the t-shirts produced for you were closely monitored" but goes on to state that quality could be an issue if working on a large scale due to the shade and measurement differences (Hameed, 2020). This comment points again to the ingrained mindsets of all agents along the supply chain and the need for greater flexibility and less standardisation in product lines while ensuring that the overall quality of make is maintained.

The Academic Perspective

There are inherent beliefs held by the manufacturers and dictated by the brands about what defines a successful product. Traditionally, garments that fall outside of this standardisation ultimately end up as fallout. A shift in both user and industry understanding of what successful products are, is important. This does not mean having lower standards, but a move away from standardisation and uniformity would help to achieve greater efficiency on the production line.

By paying a realistic price for the product, the manufacturers have the time to create more flexible strategies. Despite this remanufactured product being inefficient, if the correct (and realistic) pricing structure is put in place with a realistic overhead cost for this product line, then there is potential for this product range to work commercially. However, the impact and challenges around the marketing of this at a higher price point are to be explored.

It is worth noting that the variables and flexibility, without strong communication or frameworks, could create products with little resale value. This could be further complicated with products outside of a basic t-shirt. If not managed correctly, this has the potential to add to the issues of waste in the supply chain and highlights the need for specialised training or designers overseeing this novel product range.

The industry is notoriously known for its linear (and fast) business model (Pedersen *et al.,* 2019). In contrast, this novel system slows the flow of material through the facility compared to the usual linear efficiency goals. This has wider cost (and therefore uptake) implications, which could explain why investment in disassembly areas has not become common

practice. The systems in place and the emerging new systems continue to conflict with each other. The scale of the systems and complexity in the industry intimidates those trying to change it. Despite working with a flexible manufacturing facility, there were concerns about how this pilot could be scaled up further with the current time pressures (Hameed, 2020), highlighting that these mindsets take precedence over the utilisation of this product resource.
An integrated system is always better and more cost-effective than non-integrated (Xiong *et al.,* 2013), yet there are challenges to how this is embedded to keep it commercially viable. Collaborative take-up will be essential in gaining momentum and ensuring that this product can be re-utilised, as embedding systems will require both the brands and the manufacturers engaged to seek meaningful solutions. Having an integrated disassembly area within the CMT facility would enable greater material flows across all areas within the facility, creating opportunities to remanufacture with this fallout resource (Figure 10).

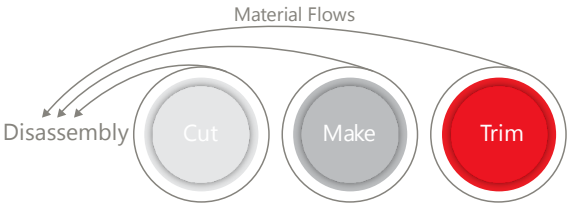

Figure 10: Material flows across the CMT facility.

A shift needs to take place, from a myopic view where speed and efficiency rates are directly linked to one where volumes of material processed and resource efficiency are connected. When this systemic viewpoint shifts, then greater developments can become more widespread. As the theory of resource efficiency WPRem works, it is the practical application and investment that has slowed its adoption.

Conclusions

The purpose of this study was to test out the capacity of working with WP fallout in a factory setting working towards scalable solutions. This pilot test delivered t-shirts that utilised 100% factory fallout (overproduction or A&B Grade fallout). This evidenced the proof-of-concept for WPRem.
The pilot test and reflections from both the industry and academic perspectives highlighted the complexities faced when a product slows down the production line. While the tests evidenced that products can be made in scalable environments, the interviews highlighted logistics barriers and time pressures that made this less viable. To successfully design for WPRem in scalable settings, further collaborative buy-in needs to take place.

Identifying and profiling the hidden value in this waste resource has enabled further discourse with the manufacturing facility around other possible opportunities with this resource. By giving the manufacturer agency and flexibility over the product, deeper collaborative partnership ensued. There was a turning point in this process from the more usual client/customer relationship to a connection where two-way dialogue in the decision-making process took place. This shift meant that brainstorming and problem-solving took place together, rather than being locked in by the designer or brand. Each agent along the supply chain needs to be able to feed information back and forth to enable greater streamlining. The expertise and knowledge held by each agent have value in creating greater resource efficiency. This field test has demonstrated that this free-flow discussion can still be achieved remotely. The test evidences the need to slow down and allow discussion and solutions to be found, pooling expertise from the different parties.
The aim was not to test the commerciality of the product but to explore the realities of working with the product in a scalable setting. This pilot study has enabled the development of two process diagrams that bring further illumination to the process of WPRem in a manufacturing facility.

Acknowledgments

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