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A Shared Vision: The importance of Knowledge Exchange through Co-design in Scaling Circular Strategies for Fashion Remanufacture – Case studies from global perspectives

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Abstract: Overproduction in the fashion industry poses a significant challenge, leading to excessive resource use and rapidly growing textile waste before garments reach consumers. The Circular Economy (CE) is gaining recognition as a means to reduce resource consumption through various strategies integrated into product lifecycles. However, effectively scaling these strategies to achieve tangible impacts remains underdeveloped. This paper draws on research projects that collaborate with industry partners to incorporate remanufacturing into existing supply chains. It highlights the essential knowledge exchange required for implementing circular production methods, aiming to identify strategies necessary for scaling. The paper enhances understanding of how remanufacturing pre-consumer textiles can be integrated into large-scale fashion business settings. Through two practice-based research projects, one with a major fashion brand and the other with a large garment factory, the research investigates how co-designing pilot projects as a form of knowledge exchange can facilitate the scaling of circular strategies in fashion production. These projects are designed to build capacity, enabling the industry partner to develop systems that can expand the implementation of remanufacturing excess stock.

While extensive research exists on circular strategies, there is limited understanding of practical implementation and how collaborations between research and industry can foster a knowledge exchange that supports the transition to circularity. The implementation of remanufacturing, like other circular strategies, depends on adapting processes contextually with a clear understanding of the industry's existing parameters and developing design responses that can effectively maintain value and recirculate garment stock.

Introduction

Overproduction has become normalised, with brands padding sales forecasts (Pucker, 2023), while on the production line, it is used to mitigate any faults found during quality control. Overproduction also accommodates possible design re-runs that the brands may request later in the season, allowing for time-efficient lean production strategies. In addition to the overproduction generated by factories, estimated to be between 25% and 47% above the orders placed by brands (Runnel et al., 2017), it is also estimated that up to 30% of garments produced by brands are never sold (*Global Fashion Agenda: Prosperity vs. Growth*, 2021). While the actual figures on pre-consumer textile waste are difficult to ascertain due to lack of transparency, it is well documented that much of this whole product (WP) fallout is ending up in waste streams of landfill and incineration (Child, 2020). Currently, less than 1% of the material used to produce clothing is recycled into new clothing (Anguelov, 2021; Ellen MacArthur Foundation, 2021). This reflects a loss of resources and inherent value in this material, as brands primarily offload excess stock through discounting—often below profit margins or leaving it with the manufacturer to dispose of.
While many micro-businesses are utilizing upcycling on a small scale, the impact on the overall resource wastage is minimal (Ellen MacArthur Foundation, 2017; KeBler et al., 2021), perhaps due to the challenges of embedding remanufacturing within existing supply chains. Finding pathways for large-scale fashion businesses to implement remanufacturing is critical for reharnessing the resources in pre-consumer waste. For now, traditional linear production using virgin

materials remains cheaper since raw materials often have low value to begin with (Shephard and Pookulangara, 2023), challenging the incentive to remanufacture. However, Walter Stahel notes, wasted material is also wasted money (Stahel, 2019), meaning that increasingly industry stakeholders are looking to exploit the potential economic benefit of 'remanufacture' or 'upcycling'. This presents an opportunity to leverage these economic factors for the environmental benefits of circular economy strategies such as remanufacturing.

This research examines remanufacturing as a strategy that can revalorise pre-consumer waste by making new products that have the potential to offset new production. Remanufacturing is framed as an emerging approach to production, using a series of linked processes that use a degree of process-level industrialization to attain scale (Dissanayake & Sinha, 2015; Wen-hui et al., 2011). Using collaboration as a strategy, this research calls for co-design and co-development in response to issues of shared concern. Johnson (2020) highlights Knowledge Exchange (KE), or Knowledge Transfer, as a key output of academic research, which can offer greater insights into the viability of remanufacture as a design strategy in a scalable setting. While there is extensive research on the value and potential of circular initiatives in fashion production, there is limited literature on what the implementation of these initiatives looks like and how they can be successfully scaled. This paper unpacks some of the opportunities that arise through an increased focus on circularity while highlighting how KE can offer a step change towards embedded change.

Methodology

To explore scalable solutions, each designer/researcher, referred to as a re-designer, collaborated with an industry partner to reintegrate pre-consumer waste, such as excess stock and product fallout, into the production line. Both pilot projects used action research methodology, allowing the re-designers to work from within the process through iterative cycles of testing, reflecting, and refining (Somekh, 2003). This paper examines these projects using qualitative data gathered from notes, observations, interviews and questionnaires, to compare, divide them into phases and identify characteristics that can facilitate remanufacturing in large-scale industry settings.

The case studies presented clarify tactics and key skills necessary to implement remanufacturing within the context of a large fashion brand and a garment factory. They highlight strategies for moving circularity from theory to practice and underline the importance of collaboration and knowledge exchange in advancing and replicating these efforts. Developing circular products requires rethinking business models from design through remanufacturing to supply chain and marketing (Charter, 2019).

Industry Collaborators

The research projects are collaborations between large industry partners and the authors/re-designers who bring their dual experiences in SME fashion businesses and academic research. The re-designers are positioned as the coordinators of the remanufacturing process within the industry collaboration and facilitators of knowledge exchange that can build capacity within the stakeholder teams (Dan & Østergaard, 2021). It frames remanufacturing as a series of processes that include the redesigning of garments as well as the coordination of material selection and production. This requires a foundational understanding of the fashion production system, through the SME fashion sector, that spans the product development, manufacturing and retail phase of garments. The redesign process aimed to develop garments suitable for resale without undermining the brand's or manufacturer's existing product lines (Dissanayake & Sinha, 2015).

Case study 1 is a collaboration between Borcherdt's research project and the co-located brand Country Road (CR), a well-established mid-market lifestyle brand with an Australian retail network of 150 stores (Payne, 2021). The collaboration inserted Borcherdt as the re-designer into the CR organisation, with the aim of building capacity within the brand for future replication.

Through the collaboration, a series of garments were selected from previous season stock, redesigned and then recirculated back into CR's stores. This project pilots remanufacturing

within the brand's supply chain and leverages CR's Corporate Social Responsibility (CSR) policy that includes circularity as one of its pillars. The objectives of the project were co-designed with the support of a core team at CR, setting out to explore a range of remanufacturing processes across diverse garment types. The outcomes formed a capsule collection of six styles, across 550 units, that range from minimal interventions such as overdyeing and placement printing, to high-cost processes such as dis/reassembly and laser cutting leather garments. The stock was selected from the brand's outlet store, requiring the development of stock flow overviews to facilitate knowledge sharing between the brand's outlet, technical and design teams with the re-designer. The outlet store represents the end of the line in CR's linear supply chain, where excess stock is channelled following various cycles of discounting in their primary retail stores. The selection criteria that were established included identifiable barriers preventing sell-through, high discount rates of >50%, and potential alignment to other products that would be in CR's retail stores contemporaneously.

Since the brand relies primarily on an extensive offshore manufacturing network, the project required establishing new onshore supplier relationships. This posed the challenge of finding manufacturers that are large enough to accommodate their commercial requirements while also having the flexibility to handle the complexity of new production processes. During this process, a large-scale factory that did have experience with remanufacturing withdrew since their set-up as a knitwear manufacturer made them unable to accommodate structured woven garments. A smaller factory was recruited, that had the skillset for handling the complexity of dis/reassembly. The approach undertaken by the re-designer focused on the individual garment's qualities, addressing barriers that prevented sell-through during the retail phase, including colour, functionality and fit (see examples in Figures 1, 2 and 3). This process involved the re-designer developing core ideas through prototypes and the brand's design team making adjustments. This ensured the aesthetic integrity of the brand and developed technical remanufacturing processes that would align with available manufacturing options. This close collaboration positions the re-designer as a facilitator between these parameters.

Figure 1: Case Study 1 remanufacturing outcomes. © Country Road.

Figure 2: Case Study 1 remanufacturing outcomes. © Country Road.

Figure 3: Case Study 1 remanufacturing outcomes. © Country Road.

Products developed

The six garments were redesigned and placed back into stores as a capsule collection with an additional two accessories produced from the fringe offcuts. The prices test a range of strategies, from just recuperating the remanufacturing costs (Figure 1), to adding a small profit margin (Figure 2) or reverting to the original full retail price (Figure 3). The close collaboration with the manufacturers allowed for insights into each remanufacturing process in terms of planning and costing. The knowledge exchange with the manufacturers took place via in-person meetings at the factory that focused on identifying steps that create complications during production and co-designing solutions that can simplify the process. These solutions included slightly amending the garment design and making allowances for minor variations between garments. The product launch was accompanied by a marketing campaign that highlighted the remanufacturing process and featured the local manufacturers involved in the project, linking it to other circular initiatives and the brand's CSR policy. Sales data revealed that the remanufactured products met benchmarks in line with conventionally produced garments, suggesting that the identified barriers had been addressed through the interventions. A key deliverable of this pilot project is a summary report for CR, making recommendations for future implementation, such as upstream planning for dyeing, providing pricing templates and a 'costing menu' for a range of remanufacturing interventions.

Case study 2 is a collaborative project with a Sri Lankan Garment Manufacturer and author/re-designer Child, consisting of five factories specialising in different mid-market product ranges, with 90% of its sales being in Europe (Hameed, 2020). Identifying a suitable manufacturing facility took up much of the early negotiations with this pilot test. An initial factory in Sri Lanka was identified and agreed to support the project, however, due to the scale of production, it became clear that they were unable to offer the flexibility required to reintroduce the product back into the facility. Subsequently, a smaller facility was located through contacts with the first facility, offering a scale of production that produced volumes of fallout or overproduction, with greater flexibility to respond to the complexity of working with product for dis/reassembly. Through initial discussions with the manufacturing facility, a range of whole product fallout was identified. This consisted of both, A & B grade with the addition of overproduction. It was clear from early discussions 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 the industry (p.200), and this could highlight why manufacturers are unsure how to proceed with this resource.

The pilot aimed to understand the opportunities to reutilize this product for re-sale through re-design strategies. The re-designer took on an initial design leadership role but adopted a co-design philosophy by encouraging the facility's expertise in manufacturing and the products to feed into the design development process. The aim was to produce 100 units consisting of T-shirts suitable for re-sale in the UK market. The main collaborative exercise involved proposing methods to de-label and remanufacture while demonstrating enough change in the design to allow for rebranding and re-sale. Once usable products were identified, a technical sheet was developed to outline the proposed designs. This was coupled with a two-way dialogue to reassure the manufacturers that changes could take place to the design and process, as flexibility is one of the key drivers of this project. Ensuring that the manufacturing facility had the autonomy to inform design decisions was

crucial to the success of this pilot test. Throughout, this close collaboration strategy required high levels of two-way communication with the production manager to enable a flexible and responsive design strategy.

Products developed

The t-shirts were made using WP factory fallout in their entirety (Figures 4 and 5). This was the first time the manufacturing facility had engaged with this product resource, so both the re-designer and manufacturer had to respond to challenges as they arose. This meant that the insights gained from this pilot test would highlight the barriers that other brands or manufacturers would be likely to face if this was systemically embedded into the supply chain. For this pilot test, the outcomes were developed to understand and evidence the proof-of-concept, while the end consumer was outside the scope of this project. Waste was produced in the remanufacturing process, however, the volume of overall waste was reduced while offering opportunities to develop novel product lines. If items are going to be produced that have a resale value, more interventions and frameworks may be needed to ensure the balance around proof-of-concept and commercial appeal while aligning with a specified customer market.

Figure 4: Case Study 2 remanufacturing outcomes. © Child.

Figure 5: Case Study 2 remanufacturing outcomes. © Child.

Analysis & Insights

The live pilot tests conducted for this research allowed for inferences to be drawn from the specific brand or manufacturer, while collectively pooling this information and highlighting shared parameters outside the design sphere that evidence the complex nature of design in this field. Figure 6 synthesizes the phases of the remanufacturing process across the two Case Studies, highlighting the scaling tactics and the key knowledge areas that stakeholders bring to effective remanufacturing collaborations.

Overall, these collaborative pilot tests have established that to engage with methods of scale for remanufacture, the following parameters need to be considered alongside the design interventions:

- **Key skills and stakeholder alignment** need to be identified in collaborations between brands, factories and re-designers, including areas of expertise and scale. As the framework of the circular economy as a connected system has been brought to the fore by organisations such as the Ellen MacArthur Foundation, designers are increasingly understanding the need to consider the whole lifecycle while acknowledging business models, services and systems (Hall and Earley, 2019). In this instance using designers/researchers with an SME background brings a skill set that has a broader understanding of the whole supply chain, allowing for systems thinking and frameworks beyond design

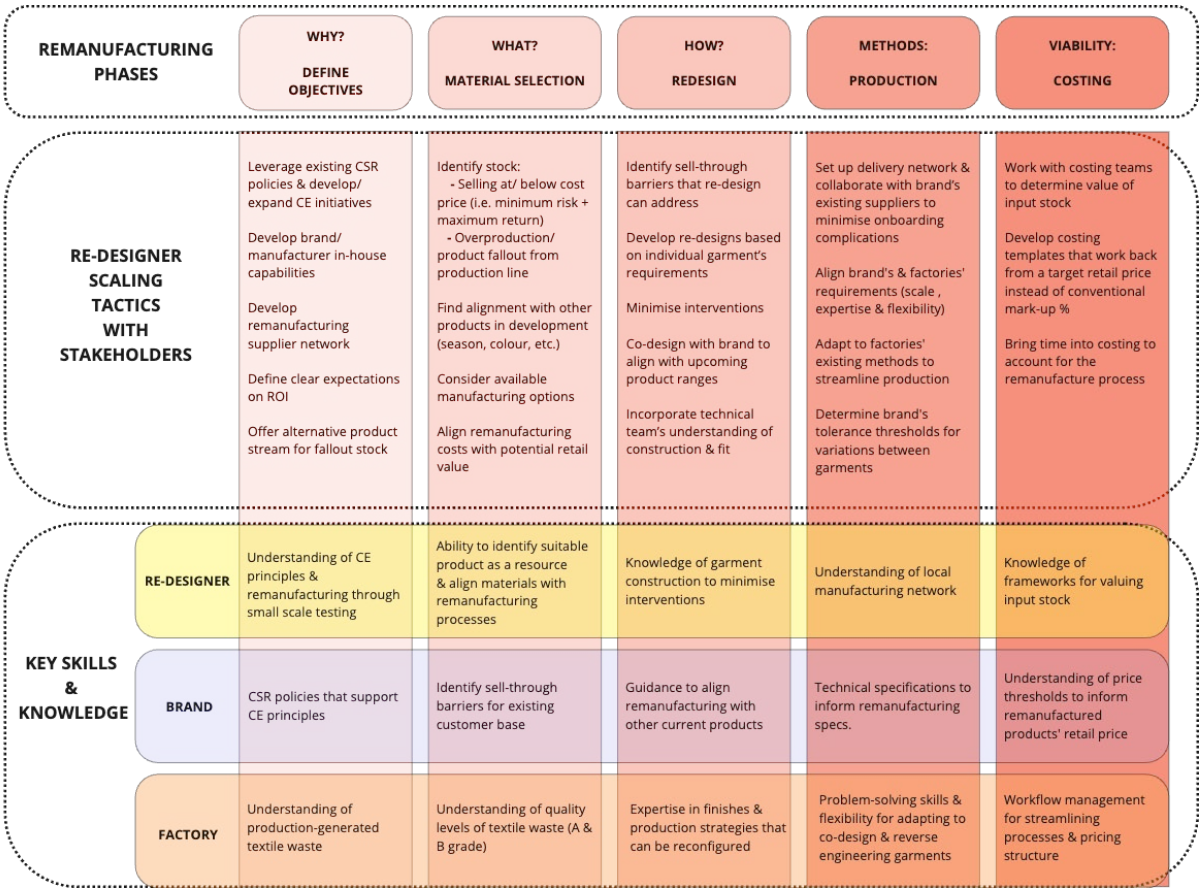

Figure 6: Scaling tactics by stakeholders within remanufacturing phases

interventions that facilitate working with remanufacture at scale.

- **Defining clear objectives** shapes all later stages of the remanufacturing process through risk tolerance, the scope of investment and expected returns, along with any design parameters necessary within the re-designed product range.

- **Material selection** requires criteria that are aligned to the brand's context and manufacturers' capabilities to help identify stock suitable to be recirculated.

- **New information flows**, such as for stock flow management, are required for the tracking of stock in real-time, identifying why it may not be selling and determining how to intervene through remanufacturing. This requires new reverse logistics and information flows, including input from retail and outlet staff back to the design and technical teams. In the manufacturing facility, reverse logistics is less necessary as the product is held on-site, but information flows are needed to ensure designers have access to the volumes of whole products available for re-design.

- **Flexibility** is required from the re-designer, the brands and the manufacturers to adapt to new processes. Manufacturers need to have the flexibility to adapt conventional factory workflows to accommodate the disassembly process. The re-designer needs to adapt to a range of brand and manufacturer parameters by developing responsive solutions that draw from fashion design practice while thinking about scalability. This role is characterised by the fluid shifting between external consultant, facilitator between entities and co-designing alongside existing teams.

- **Context-specific redesign** solutions are required for aligning remanufactured with conventionally produced garments, not

only for each brand but for each garment. This allows for the remanufactured products to be recirculated via the existing retail channels of a brand or novel ranges, which potentially offsets new production.

- **Costing** of remanufactured garments differs from conventional production as the valuation of existing garments is more subjective than raw materials. This requires new costing frameworks that depart from conventional markups, such as working back from target retail prices. This also needs to factor increased time into the costing framework to account for the deconstruction and remanufacture time.

- **Effective communication** is critical for the knowledge/information flows between the brand and manufacturers and is also foundational to the role of the re-designer as facilitator. These projects used a wide range of methods, including in-person and online meetings, summary emails with detailed instructions, questionnaires, interviews, technical sheets, mood boards, and WhatsApp to facilitate the two-way process involved in KE (Ahmed et al. 2022). Other examples of these are increasingly seen in the sphere across academia and industry, such as BFFT and the European Commission Horizon 2020, evidencing collaborative approaches of research with impact.

Despite design outputs, market levels and industry collaborators being from different global contexts, the shared insights highlight the potential frameworks that could support wider uptake and serve as a reminder of the importance of industry collaborations in scaling methods of remanufacture.

Conclusions

This study has demonstrated how strategic knowledge exchange through co-designing pilot projects with industry can increase capabilities for remanufacturing. It draws from dual perspectives in methods of remanufacture to understand the interventions needed to support scale through fostering knowledge exchange with the partnering companies.
The pilot tests looked to facilitate KE in a 'live' industry setting, understanding that close collaboration and co-designing build capacity within industry partners and are critical for both scaling and working towards remanufacture as a transition strategy for the circular economy. Insights from this enable a greater understanding of the parameters outside of design to support the success of remanufacture as a design strategy. This work is the first endeavour to bring together dual perspectives to support designers and researchers navigating this complex design space where re-designers are becoming facilitators within brands and manufacturers. This paper highlights the importance of KE in developing systems that can be scaled. To this end, we provide a series of tactics drawn from industry collaborations, serving as examples of actionable knowledge for those wanting to engage in scalable solutions for remanufacture. We envision future efforts to expand on this scale, leading to further integration of remanufacturing by brands and manufacturers as a transition strategy to the CE, whilst remembering that offsetting new production with remanufactured garments is critical for this process to have impact instead of being an add-on (Cooper & Gutowski, 2017; Fortuna & Diyamandoglu, 2017; Woolridge et al., 2006).

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