



05. New Horizons

Strategic Design for Remanufacturing

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The way we design products determines how well they are suited to future recovery scenarios. My PhD research explored how to design products for them to fit in a circular economy. Before turning to recycling, which eventually every product should be designed for in order to loop all the materials in an economy, there are several other strategies that need to be considered that extend the lifetime of products.

Remanufacturing is one of the product recovery strategies in a circular economy. In the remanufacturing production process, used products are returned to their original specifications before they are resold to the market. When compared to original manufacturing, remanufacturing results in lower raw material consumption and reduced carbon emissions. Despite having been operative for decades, across multiple industries, like cars, medical equipment and airplanes, remanufacturing remains a niche company activity. At the moment it remains largely underexplored for building products as well.

Engineering knowledge on how to design products to improve the fit with the remanufacturing process is widely reported on in academic literature. However, a strategic link is missing, since decision-making to remanufacture a product typically takes place when the product reaches End-of-Life. Which implies that remanufacturing is separate

from a companies' core business or strategy. My thesis therefore explores the role of strategic design in the context of remanufacturing. So, *how can strategic design contribute to the wider implementation of remanufacturing?*

To make things explicit, *design for remanufacturing investigates the suitability of a product to be remanufactured*. Strategic design, as part of this, takes place in the early phase of the product development process and aims to promote a wider implementation of remanufacturing in industry. It determines the extent to which a product meets market needs in all of its product use-cycles, what its functionality should be in each of these cycles, and whether it supports a company's long-term objectives.

My PhD research is based on literature review, company workshops, interviews, an in-depth case study and methodology development. The outcomes include an overview of the design management roles for remanufacturing, learning materials for companies, and the 'Circular Product Readiness' method.

The Strategy Map

One of the outcomes of my research, the Strategy Map, is developed based on insights from an in-depth case study research on a production printer



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company. It presents 12 main points through which the case company can proceed with advancing the integration of Design for Remanufacturing in strategic design. Activities central to this map are the importance of having a design vision that advocates designing products for multiple use-cycles, having an integrated business strategy for newly manufactured and remanufactured products, and integrating remanufacturing in customer research.

Circular Product Readiness

The second outcome I'd like to highlight is the Circular Product Readiness method. This method provides a means to give guidance to and monitor the status of circular design implementation at companies. Through literature review and knowledge coproduction sessions with experts, 20 circular design indicators were identified that enable monitoring readiness levels of companies. These indicators cover all product life-cycle stages in six themes, from strategy and planning to recoverability. It helps companies assess their readiness level to design the different aspects of circular product service systems. The method helps coordinate Design for Remanufacturing in relation to other circular design strategies a company applies.

Remanufacturing is often viewed as a technical, End-of-Life solution, which offers strategic benefits. When viewing it as a strategic approach, remanufacturing can increase its impact on business development and environmental sustainability. Once fully integrating remanufacturing, the recovery potential of existing capital increases. It allows companies to better attune their value propositions for remanufactured products to their

customers and, with that, more optimally leverage the technical remanufacturing potential of products. Companies thus, can make more effective use of their resources and minimize wasting end-of-use products that are still functional.