Repurpose driven design - a practice-based evaluation of design methods for repurposing

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Repurpose Driven Design - A Practice-Based Evaluation of Design Methods for Repurposing

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Abstract: The circular economy as a system change is gaining more attention, reusing materials and products is part of this, but an effective method for repurposing seems to be missing. Repurpose is a strategy which uses a discarded product or its parts in a new product with a different function. Literature on specific design methods for 'repurposing' is limited and current design methods do not specifically address repurpose driven design. This paper aims to contribute to the literature on repurpose as a circularity strategy by evaluating repurpose driven design processes which are deployed in practice and evaluate to what extend existing design methods are suited for repurpose driven design. Building on a multiple case study two main design approaches are identified. First, a goal-oriented approach in which a client commissions the design studio. Second, a resource-oriented approach in which a discarded product or its components is the starting point of a design process initiated by the designers. Although both approaches follow a more or less standard design process, each intervenes with repurpose specific input at different phases in the design process, depending on the role of the designer. Results show that in order to be able to deal with the inconsistencies of discarded products, specific repurpose-related tools are required for an efficient and effective repurpose driven design process. Future research should address these issues in order to develop comprehensive and practical tools that accommodate the two repurpose driven design approaches.

Introduction

Academics and practitioners are working on methods and systems for a Circular Economy (CE). Key elements in CE are reducing, reusing, recycling and recovering materials in production and consumption processes (Kirchherr, Reike, & Hekkert, 2017). This has evolved into the 9R concept recognising further value retention options like 'refurbish', 'remanufacture' and 'repurpose' (Potting, Hekkert, Worrel, & Hanemeijer, 2017; Reike, Vermeulen, & Witjes, 2018).

Various academic studies refer to repurpose as a strategy which uses a discarded product, or its components, in a new product with a different function (Sieffert, Huygen & Daudon, 2014; Potting et al., 2017; Kirchherr, Reike, & Hekkert, 2017). Repurpose is an interesting option for reuse of existing material flows that carry too much value which may be lost through recycling or recovery. In fact, with repurpose the life span of a product, or its components, is extended and the use of new 'virgin' material is avoided.

Repurposing is considered an important strategy for the transition towards a CE (Lüdeke-Freund, Gold and Bocken, 2018). However, literature on specific design- and business models for repurposing is limited (Lüdeke-Freund et al., 2018). The difficulty seems to be that those streams of discarded products are not uniform, of varying quality, and not endlessly and at all times available. Although repurposing is challenging, numerous examples can be found in practice. Some design studios practice Repurpose Driven Design (RDD), which addresses product design using discarded products, rather than designing products optimised for repurpose after being discarded.

Building on a multiple case study, this study evaluates RDD processes that are deployed in practice and evaluate to what extend existing design methods are suited for RDD. This research contributes to literature by identifying two main design approaches and proposing further research for the development of practical tools for RDD.

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Theoretical background

A generic design process consists roughly of five phases: analyse, define, design, finalise and implement (Bobbe, Kryzwinski & Woelfel, 2016). The literature describes several classical design methods that provide several tools for performing activities within each phase (Hubka & Eder, 1992; Pahl & Beitz, 1996; Roozenburg & Eekels, 1995). However, most generic design methods describe the creative problem-solving process and do not contain specific strategies or tools for circular product design. To fill this gap, in the past decade specific design methods have been developed for circular product design containing strategies and tools for incorporating resources and sustainable business models in an effective way.

Den Hollander, Bakker and Hultink, (2017) describe a typology of design approaches for circular product design and make a distinction between design for product integrity at product and component level and design for recycling at a material level. Two frameworks for circular product design are discussed: 'Products That Last' (Bakker, den Hollander, van Hinte, 2014) and the 'Design for X framework' (Franconi, Badalucco, Peck, & Nasr, 2019).
Products That Last (Bakker et al., 2014) provides a theoretical strategic framework containing business model and product design strategies that are useful to lengthen and slow down product loops, which RDD also intends. Although elements of this framework are indispensable for circular product design, it does not provide specific tools for RDD addressing variabilities of discarded products.
The Design for X framework is focused on product development for the CE and is 'applicable for the earlier design stages' (Franconi et al., 2019). This method provides detailed strategies that are combined with the product lifecycle, ensuring incorporating the entire lifespan and possible next cycles. However, RDD itself is not (yet) specifically elaborated in this method.
Moreover, these frameworks , as well as generic design methods, take the desired functionality of a product as the starting point for the design process. The materialisation of the product design (i.e. the selection of the materials) takes place at one of the later phases in the process. In contrast, for RDD the discarded components of products or materials are the starting point from where the search for an application in a new product starts.

A design method that takes a material as starting point is the Material Driven Design (MDD) method (Karana, Hekkert, & Kandachar, 2008). This method "facilitates the design processes in which materials are the main driver" and helps to "create design requirements and objectives with a material at hand" (Karana, Barati, Rognoli, & Zeeuw van der Laan, 2015). Oskam et al., (2017) used this method for finding new applications for discarded textile waste and show that this method is valuable to evaluate the value potential of discarded materials as well. Handbooks and guidelines that specifically address the use of recycled materials and plastics are also available (Gort & Gerrits, 2015). However, the MDD method as well as these guidelines do not cover the entire design process, but are mainly of use in the analyse and definition phase and do not address the limited availability in time and quantity of the discarded products, components or materials. Moreover, it is assumed that the material is still extensively to be manipulated and deformed, which likely is not desirable in a repurpose driven process.

Method

In practice several companies are working following a RDD approach. Therefore, the design process of design studios that use repurpose in their product development is analysed to see which methods are used in practice. These insights are compared to existing design methods from literature.

For this research a multiple case study method (Yin, 2017) is used to study the design processes with discarded products. Table 1 shows the overview of cases. Five design studios, experienced in repurposing, and two academic cases of graduation projects were evaluated in retrospective through interviewing the designers about a specific RDD case. In a follow-up interview their approach was studied more in-depth, using a process perspective.

Design studio	Reference name	Type of company	Case / material stream	Repurposed into:
Studio Hamerhaai	A	Small design studio	Wood from transport boxes	Interior object
Verdraaid Goed	B	Medium design studio	Plastics from train time tables	Serving tray
Tolhuijs	C	Small design studio	Metal fencing	Wall rack
Superuse	D	Medium design studio	Windmill blades	Playground
The Upcycle	E	Small design studio	Old bicycle tires	Belt
Bugaboo (academic case)	F	In-company design studio	Obsolete spare parts from strollers	Handcart
Ahrend (academic case)	G	In-company design studio	Filing cabinet with roller doors	Bench

Table 1. Overview of the selected cases and characteristics

Figure 1. Case for company G: academic case for Ahrend - from filing cabinet to bench. (R. Sperlings, 2021)

For the follow-up interviews, an online template was used to guide the conversations (see figure 2). The template is based on the generic design phases , as identified by Bobbe et al., (2016). The interviewees were asked to elaborate on the design process that was followed during their specific RDD case. Their RDD process was summarized in main steps and tools used, which were written on coloured dots, and placed underneath the five phases, where the five distinct colours represent the phases. Thereafter, the interviewees were asked to determine which phases, steps and tools were most important and specific for the RDD process.

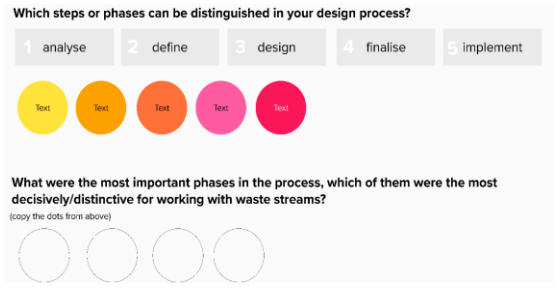

Figure 2. Online interview template

The multiple-case study consists of a within-case analysis and a cross-case analysis. Each case study resulted in an individual case report and a visualisation of the design process based on the interviews and the online interview template. Next, the design processes found for each case were compared using a pattern-matching logic. In this comparison, similarities and differences between the processes were sought related to the role of the designer, the starting point and the design methods and tools used.

Results

The within-case analysis and cross-case analysis resulted in a detailed description of the phases, steps and tools to provide a detailed insight in the design process and pinpoints the moments in which repurpose-related aspects did occur. Figure 3 shows that each of the five generic design phases were also part of the design process of the RDD case (F). This was also found in the other six cases. All design studios work with discarded products and thereby analyse repurpose aspect, such as material, history, functionality, form, availability, quality and quantity. However, the case studies show that their approach of the design process vary. Two main approaches of the RDD process were identified: a goal-oriented approach and a resource-oriented approach.

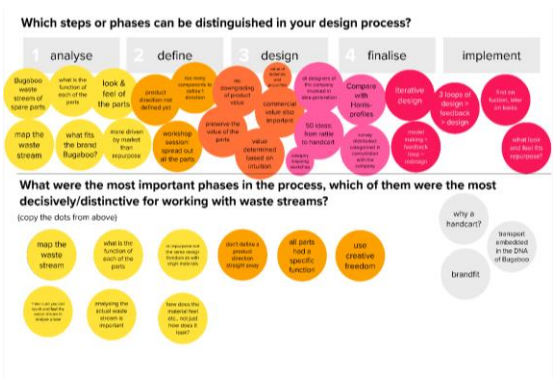

Figure 3. Interview results Case F: Bugaboo

In the cases B, D, F and G a goal-oriented approach was found in which a client initiated the design process by commissioning the design studio. In these cases the analyse phase of the design process was important, because the available discarded products have to be inventoried and analysed. The available waste streams determined to a large extent decisions in the RDD process (Figure 4). Design studio B and D followed the steps of the generic design process and have developed additional tools for RDD. Within a project, both studios worked with a project team of different stakeholders. These two design studios are operating as designers and as strategic consultants.

In the cases A, C and E a resource-oriented approach was found in which the material and the form of the discarded product is the starting point for the design process. Motivated by 'rescuing' discarded materials the designers looked for and chose a waste streams after which a design process was started. The waste stream was explored in terms of repurpose aspects (Figure 4). Parallel application possibilities were investigated in a less analytical and more intuitive manner than in RDD using a goal-oriented approach. The specific material properties and the shape determined the final application. In this approach the designers worked more entrepreneurial.

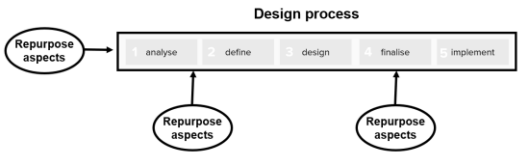

Figure 4. Different timing of needed RDD related input

All cases show that working with discarded products can be laborious and inefficient, since they are rarely uniform and often vary in quality. For example the wall rack in case C is made of discarded fences, which are often damaged. In all cases preparation of materials before the production process seems crucial and has to be taken into account in design related choices (Figure 4). Storage and transportation are additional challenges. All designers strive to keep as much value as possible of the discarded products, which can be an ecological, economic, emotional or social value.

Discussion and conclusion

All interviewed designers (professionals and students) work with a more or less standard generic design method as described by Bobbe et al., (2016) for RDD. It is the phase in the process in which the designers intervene with repurpose specific input for material, history, functionality, form, availability, quality and quantity which differs. This phase in the process depends on the chosen starting point which relates to the role the designer has in the design process. The information needed or interventions to be taken would suggest a need for specific tools and methods at that specific point in the generic design process. The designers working with a goal-oriented approach for an external client choose a typology (Hollander et al., 2017), a strategic framework like Products that last (Bakker et al., 2014) or Dfx (Franconi et al., 2019), and in addition they use specific self-developed tools for RDD in the early phases of the design process (analyse and define). Both designers working with a resource-oriented approach as well as designers working with a goal-oriented approach use a method similar to MDD for finding a meaningful application for the discarded product or component they select. The MDD tools and methods are helpful for RDD. However, the method is not supplying tools and methods for repurpose relevant aspects like varying availability, quantity, and quality. These aspects are relevant for RDD when production, upscaling and supply chain issues are being incorporated in the design choices. Besides this the MDD method stimulates manipulation of materials whereas within repurposing the manipulation of the resources available are to be minimised in order to use the value as it is captured in the resources supplied. Future research should develop and validate comprehensive and practical tools for RDD in addition to existing methods for circular design. These tools are to be deployed in earlier and in the later stages of the generic design process, for efficiently and effectively inventorying, evaluating, manipulating and using discarded products.

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