



Use to use – A user perspective on product circularity

Anneli Selvefors^{*}, Oskar Rexfelt, Sara Renström, Helena Strömberg

Design & Human Factors, Industrial and Materials Science, Chalmers University of Technology, SE-412 96, Gothenburg, Sweden



ARTICLE INFO

Article history:

Received 28 June 2018

Received in revised form

20 February 2019

Accepted 11 March 2019

Available online 14 March 2019

Keywords:

Product lifetimes

Product circularity

Circular product design

Sustainable consumption

Circular economy

User-centred design

ABSTRACT

The discussion regarding product circularity is often framed from a production and business model perspective. In this paper, people's consumption processes are taken as a new point of departure and a re-framing of product circularity from a user perspective is proposed to complement the current narrative. This user-centred perspective emphasises the importance of product exchange, which underscores that products can be transferred in tight loops from one user to another, i.e. from Use to Use. It also highlights a number of challenges and practicalities that circular paths of consumption may entail for people in everyday life, and thus points to new opportunities for designing products and services that can create enabling preconditions that make it possible, more convenient, and more preferable for people to circulate products. These design opportunities can be categorised into four design strategies that can support the development of products and services fit for circular consumption processes. How the proposed reframing compares to the current narrative is discussed and recommendations for future research are proposed.

© 2019 Elsevier Ltd. All rights reserved.

1. Introduction

There is a growing need to reduce resource-throughput related to products in order to decrease the negative environmental pressures associated with the prevalent throwaway mentality in many societies. A move away from today's linear take-make-waste logic to a circular economy is one approach argued to not only have the potential to reduce the associated negative environmental impacts but also to be beneficial for businesses and people (Ellen MacArthur Foundation, 2013; European Commission, 2014; United Nations, 2016).

To support a transition to a circular economy, a growing number of designers and researchers are now exploring different ways to circulate materials and products so that their value can be recovered. The design opportunities proposed are commonly framed in relation to the generic stages of a product life-cycle (see e.g. Ellen MacArthur Foundation, 2013). As illustrated by the shading in Fig. 1, value can be recovered through three main opportunities. The first two opportunities address ways to extend a product's lifetime, i.e. the duration of the period that starts at the moment a product is

released for use after manufacture and ends at the moment a product becomes obsolete beyond recovery at a product level (as defined by den Hollander et al., 2017). Firstly, a product can be designed for extended use through strategies such as design for durability, design for repair and maintenance, and design for attachment and trust (see e.g. Bakker et al., 2014a; van Nes and Cramer, 2005). Secondly, products and services can be designed so that products can be reused after they have been redistributed, remanufactured, or refurbished (see e.g. Go et al., 2015; Pigosso et al., 2010). Once the product has become obsolete beyond recovery at the product level, the third opportunity becomes relevant, which is that material and parts can be recovered through recycling and reuse of parts. Some of these design strategies, along with additional design opportunities, are also sometimes framed in relation to key concepts within circular economy. For instance, Bocken et al. (2016) categorise design strategies to slow and close resource loops, while den Hollander et al. (2017) group strategies that can be used to resist, postpone, and reverse product obsolescence, and Haug (2016) discusses opportunities to increase product longevity by addressing intrinsic and extrinsic product resilience.

The design strategies discussed above, both in relation to the product life-cycle and the circular economy key concepts, present important possibilities for designers to create enabling preconditions for prolonged product lifetimes. However, whether products designed for prolonged lifetimes will actually be in use for longer and/or more frequently utilised depends on the people using

^{*} Corresponding author.

E-mail addresses: anneli.selvefors@chalmers.se (A. Selvefors), rex@chalmers.se (O. Rexfelt), sara.renstrom@chalmers.se (S. Renström), helena.stromberg@chalmers.se (H. Strömberg).

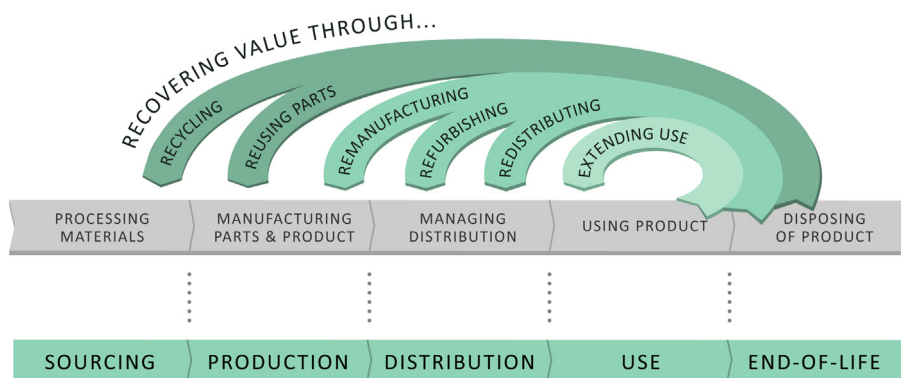


Fig. 1. Ways to extend product lifetimes and close resource loops in relation to a generic product life-cycle.

them. Users¹ decide when and how to obtain, use, not use, and rid themselves of products. Their decisions will determine whether products are consumed through circular consumption processes, whether they are extensively utilised, and whether they are passed on to a new user once need for them has ceased. Hence, users have a critical role to play in a circular economy and can be considered central enablers (cf. Gallaud and Laperche, 2016).

The role of users in the circular economy has to date been underestimated and underexplored (Camacho-Otero et al., 2018; Lofthouse and Prendeville, 2017, 2018; Wastling et al., 2018; Welch et al., 2017). Despite this, a user perspective is not only claimed to have potential to create opportunities for reduced resource throughput, but also to result in innovative circular products and services that are commercially profitable (Lofthouse and Prendeville, 2018) and attractive to people in everyday life (Selvefors et al., 2018). To increase the understanding of the role of users for product lifetimes, recent research has addressed consumer expectations of product lifetimes (Gnanapragasam et al., 2017; Wieser et al., 2015), consumer acceptance of circular processes and business models (Camacho-Otero et al., 2017; Mugge et al., 2017), user attitudes and barriers, for instance to repair and maintenance activities (Ackermann et al., 2017; Young, 2017), and design for circular behaviour (Wastling et al., 2018; Piscicelli and Ludden, 2016). Although these and other contributions have helped to nuance the understanding of product lifetimes from a user perspective, too little attention has been paid to the practicalities of circularity in everyday life.

While people have many options to shift to circular consumption patterns, these options are often considered impractical and challenging, as they require more time, effort and planning than today's linear consumption patterns. For instance, selling a product on the second-hand market requires more work and is more cumbersome than disposing of it as trash or storing it away (Lehtonen, 2003; Lucas, 2002). As a result, second-hand selling is perceived to be less convenient and less preferable. If linear instead of circular consumption processes are preferred, products will not be circulated and the transition to a circular economy will not gain momentum. To make circular consumption preferable it is essential to increase the understanding of *what circular consumption entails for people in everyday life* with regard to using, managing, and circulating products. Gaining insight into these types of aspects is key to making circularity happen, as this will enable the development of circular offers (products and services) that better fit people's needs in everyday life, and will thus have a higher potential to

decrease the number of products placed on the market.

In order to contribute to a more profound understanding of the practicalities of circularity in everyday life, this paper aims to present a user perspective on product circularity focused on people's consumption processes. Further, the paper will discuss what opportunities and challenges for reducing resource throughput such a framing highlights, both in relation to prolonging the useful life of products and increasing their utilisation. Hence, this paper will contribute to complementing the discourse on how product lifetimes can be understood and managed.

2. Approach and methods

The content presented and discussed in this paper is the result of an explorative and iterative process that has included both theoretical considerations and practical experiences over the course of several years.

The process was initiated 2013 with an explorative workshop in which seven researchers in the fields of User-centred Design and Sustainable Design explored how product circularity could be framed with the user taking centre stage. Already existing and common representations of product circularity were examined in order to obtain an understanding of how users were represented in these, and to confirm the need for a new representation. This resulted in an initial model of how people's consumption processes relate to the product life-cycle (later refined into Fig. 2 in this paper).

The capability of the developed model to contribute to a user perspective and inspire new ideas was tested in three different ways. Workshops were held with six Swedish companies, including manufacturing industries and retailers (altogether four workshops, each with 6–8 company representatives). The model was also tested by design students in courses on Sustainable Design at Chalmers University of Technology (altogether on six occasions, each with circa 30 students). The task for both company representatives and students was to come up with innovative ideas related to product circularity. The ideas and experiences were reflected upon afterwards both through group discussions and surveys. In addition, the model and the thoughts behind it served as the basis for a Bachelor's thesis aimed at exploring how a suitcase, a mobile phone and a food processor could be redesigned for circular consumption (Evertsson and Johansson, 2017). The experiences of the thesis students were monitored throughout their project and the students were interviewed after their exam. The testing of the model, and the feedback received from both academia and industry helped to identify the need for a more detailed description of how consumers can circulate products. A model of different paths of consumption was therefore created to visualise and describe

¹ Regarding wording: The term 'users' is used instead of consumers to emphasise people's active role in the consumption process, see also section 2.2 for a discussion.

common ways to circulate products, such as renting, borrowing and buying second hand (Fig. 3 in this paper).

The overview of consumption paths was used as a basis for exploring how circular consumption influences people's everyday lives in terms of the activities they engage in and the consequences these may have. Three workshops were conducted (each with 3–5 participating researchers) to map out activities, challenges and practicalities in relation to different paths of consumption, e.g. renting, borrowing, and buying second hand.

As a next step, different design opportunities were deduced (and phrased as design guidelines) from the descriptions of user activities and the challenges associated with circular consumption. The basic principle for this work was that each challenge that users face presents an opportunity for design. To test and evaluate the applicability of the guidelines they were applied in four Master's thesis projects. The projects concerned the design of a tent for a rental service (Hagman and Wendt, 2018), a sofa for a furniture subscription service (Rosman, 2018), earphones for a rental service (Philipson and Wallner, 2017) and cars for a sharing service (Kuikka and Swenne, 2017). All students were interviewed retrospectively to gain insight into both their experiences of applying the guidelines and particular user challenges and practicalities they had identified in their projects. Three additional Master's thesis projects on the theme of product circularity were also analysed and the students conducting these were also interviewed after their exams. Based on the collective experiences from these projects, a greater understanding of different types of user activities and everyday challenges was gained. Based on this understanding, the design opportunities were refined and categorised into four design strategies related to different stages of the circular consumption process (see section 5).

To explore how the identified design strategies relate and compare to previously suggested strategies for circular product design, the design strategies were contrasted with existing guidelines (see section 5). Existing guidelines were identified by reviewing literature that compiles a set of such guidelines, as well as papers that focus on one specific design strategy.

3. People's consumption processes

As highlighted in the introduction, important aspects related to people's consumption processes remain underexplored in relation to product lifetimes and product circularity. This section will address some of these aspects and discuss how they can contribute to an increased understanding of product lifetimes from a user perspective.

3.1. Taking people's consumption processes as a point of departure

The prevalent focus in literature regarding design opportunities for circularity is framed from a production and business model point of view. The current emphasis on opportunities for improving products and production processes is not surprising given the field's strong eco-design heritage (Lofthouse and Prendeville, 2017). In its early days ecodesign was techno-centric and design opportunities were often framed in relation to stages of a product life-cycle. The focus was primarily on delivering more sustainable products and making the production process more sustainable; the role of users and consumption was often limited to a use or utilisation stage in the product life-cycle, preceded by a distribution phase and followed by a collection or end-of-life phase (see e.g. Brezet and Van Hemel, 1997; European Commission, 2014). More recently, the exploration of opportunities for innovative business models that advocate access instead of ownership (see e.g. Gruen, 2017) and services for sharing and collaborative use of products

(see e.g. Botsman and Rogers, 2011; Leismann et al., 2013), have helped to expand the narrative through which design opportunities for circularity are discussed. However, the majority of contributions in circular economy literature today are still based on a simplified framing of users and their consumption processes.

The current framing results in a narrative that emphasises how companies can contribute to the circular economy by either providing products that last a long time and/or are fit for circular (re-) production flows, or by offering services that can increase product utilisation. Although innovations in production and business are essential for reducing resource throughput and for bringing about a transition to a circular economy, changes in consumption are equally important (EEA, 2015; Kirchherr et al., 2017; De los Rios and Charnley, 2016). Hence, there is a need to think beyond the current narrative of exploring opportunities for circularity solely from a production and business model point of view, and also address opportunities from a user and consumption point of view.

When aiming to explore opportunities from a user and consumption point of view, a shift in perspective is required. In this paper, people's consumption processes are taken as the point of departure. Fig. 2 illustrates how this new point of departure complements the current narrative based on the generic product life-cycle. Just as in the product life-cycle, the new perspective includes the use phase and the potential to extend product lifetimes by prolonging the use phase (e.g. through design for durability, repair and maintenance) that are well covered in past research. Taking the consumption process as a point of departure also emphasises how people obtain and rid themselves of products, but from a user's point of view instead of from a production and business model point of view as in the current narrative.

This shift in how obtainment and riddance are viewed places the focus on *product exchange*, i.e. that products can be circulated from user to user, instead of on resource recovery, i.e. that products should be circulated back into production processes at their highest level of value. Addressing product exchange instead of resource recovery highlights additional ways through which the resource throughput can be reduced:

- Users can obtain pre-used products from other users instead of buying new products.
- Users can avoid disposing of products as trash by passing them on to other users.
- Users can increase product utilisation by passing on unused products to other users.

While these ways to extend product lifetimes and increase product utilisation are not new, they have received little attention due to not being an inherent part of the current life-cycle and business model narrative. As a consequence, the design opportunities they may involve have not received much attention either. Exploring these design possibilities and changing the point of departure from the product life-cycle to people's consumption processes requires deep insight about what circular consumption entails in everyday life with regard to associated activities and everyday challenges.

3.2. People's consumption processes and paths of consumption

Many aspects are said to influence people's consumption. For instance, aspects related to the product and the user, as well as situational influences, are commonly argued to influence what products people choose to consume (see e.g. Gultinan, 2010; Jacoby et al., 1977; Lehtonen, 2003; van Nes and Cramer, 2005 for more detailed discussions). However, while a shift from linear to

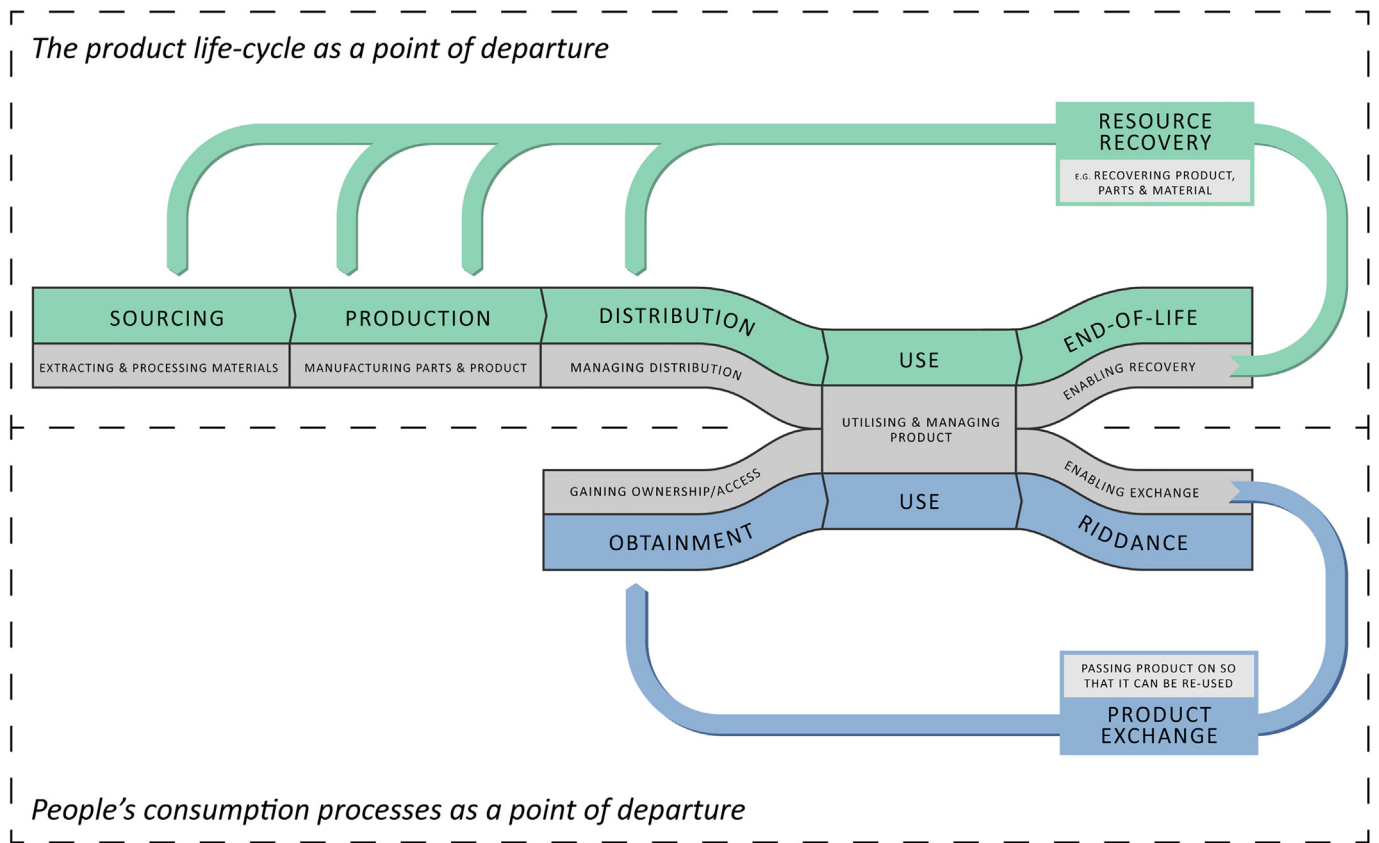


Fig. 2. Opportunities for circularity can be explored either by taking the generic product life-cycle as a point of departure or by taking people's consumption processes as a point of departure.

circular consumption processes may or may not influence *which products* people consume, it will definitely influence *how* people consume. Hence, it is essential to deepen the understanding of people's consumption processes.

The consumption process described in the lower half of Fig. 2 stems from literature on consumer behaviour, which describes consumption as a process that covers three main phases: obtainment, use, and riddance² (see e.g. Antonides and Van Raaij, 1998; Jacoby et al., 1977; Lehtonen, 2003; Lucas, 2002). Much of traditional consumer research takes a marketing perspective, with a focus on the obtainment process and how people purchase goods or services. However, in relation to circularity, addressing the entire consumption process – consisting of obtainment, use, and riddance – is central to gaining insight into new opportunities for reducing the resource throughput.

Looking closer at the phases of obtainment, use, and riddance, they can be understood as processes in which people make decisions and engage in certain activities in relation to one or more products. While some of these decisions and activities are discussed in the circular economy literature, others remain unaddressed despite being highly relevant from the perspective of circularity.

With regard to obtainment, people may for example engage in

different activities that succeed the recognition of need but precede the actual acquisition of a product, such as gathering information and reflecting on options. Such activities, e.g. comparing product alternatives, are often referred to as pre-purchase activities in consumer behaviour literature. In relation to circularity however, these activities will also include considering in *which* ways the product or function can be obtained and making a decision about how to acquire the product. People can, for instance, choose to gain ownership by buying or to gain temporary access by renting or borrowing. This also means that products can be acquired without being purchased and without financial transactions (e.g. through receiving gifts and borrowing) and that people themselves can exchange ownership of, and access to, products without company involvement. The choice of acquisition method will inevitably lead to a particular path of consumption that may require additional activities and/or decisions, such as bargaining with a private seller or planning ahead when intending to use something to be able to rent it.

Once the product is obtained the user may have to clean it, install it or in other ways make it ready for use. In addition to utilising the product, the user can engage in different activities to manage the product, such as adjusting or repairing. In time the user's need for the product can shift, due to changes related to the user or the product, which can lead to low utilisation and long periods of hibernation. Hibernation increases the risk of products ending up in prolonged storage (Lehtonen, 2003; Lucas, 2002), which can reduce their technical utility over time and make them less attractive to others. Eventually, the user will contemplate whether to keep the product, to permanently dispose of it, or to temporarily dispose of it. Jacoby et al. (1977) argue that if the

² Regarding wording: Consumer behaviour literature refers to these phases as acquisition, use, and disposal. In this paper, obtainment is used instead of acquisition to put less emphasis on buying products and more on other ways of gaining ownership or access to products. Riddance is used instead of disposal to put less emphasis on creating waste and more on making products available for someone else.

decision is to keep the product, the user can continue to use it for its original purpose, repurpose it, or store it away for potential future use. In contrast, if the decision is to dispose of the product, a number of different paths can be considered, for instance the user can sell it, trade it, or loan it to someone temporarily. All of these paths lead to further activities, such as pricing a product, cleaning it, and finding a suitable receiver. Due to the complexity of the riddance process, addressing this is critical in order to support people to release unused products so that new users can obtain them. However, as argued by Lucas (2002), the riddance phase of the consumption process has been given less attention than it deserves and needs to be further understood:

In the general economy of the household or the person, shedding off possessions can be as complex a process as acquiring them, and acts such as giving away, recycling and discard, need to be examined as different responses to this process. In many cases, there is a variously strong reluctance to discard; hoarding unused, unneeded objects is a common practice ... (Lucas, 2002, p. 17, p. 17)

The entire consumption process comprises a number of aspects, decisions, and activities that make different paths of consumption varying desirable. Adopting a new consumption path may afford users opportunities to engage in desirable activities, or may deny them such opportunities. Users can also be forced to engage in undesirable activities, as well as to be relieved of them (cf. Hiort af Ornäs and Rexfelt, 2006). At the risk of having to engage in undesirable activities, users might avoid certain consumption paths (e.g. selling used products on the second-hand market) and choose a more convenient option (e.g. disposing of it as trash or storing it in the garage). Hence, if one path is perceived as having relative advantages over other paths, it will become more desirable (Rexfelt and Hiort af Ornäs, 2009).

In summary, people make many decisions and engage in many activities throughout the consumption process that influence resource throughput. As each particular path of consumption necessitates different strings of activities and entails different everyday challenges and practicalities, the likelihood that a user chooses a circular path of consumption must be considered in light of the alternative available paths. Thus, the active role that people play throughout the consumption process must be recognised. People should not be viewed as objects, which is often done in studies with a marketing perspective (Antonides and Van Raaij, 1998), but instead as subjects who act in a sometimes limiting and sometimes enabling environment. People should be considered to play an active role in their consumption process, but it is important to note that people's actions are not always a result of active decisions; as with people's actions in general, some things “just happen”. When buying a new mobile phone, for instance, the old one may be put in a drawer without any extensive reflection and left there for years as a result of inaction. Understanding people's consumption processes in depth and holistically throughout the three phases—obtainment, use, and riddance—is thus essential when exploring opportunities for supporting product circularity.

4. Use to use – a user perspective on product circularity

While the previous section highlights the need to address product circularity from a user perspective with a focus on people's consumption processes, this section highlights what such a perspective can contribute to the understanding of product lifetimes. Building on Selvefors et al. (2018), a consumption cycle is presented to show different paths of consumption and how these are linked through product exchange to enable circularity. The

concept of Use to Use, i.e. circulation of products in tight loops between users, is also described.

4.1. The consumption cycle

As argued above, there is a potential to explore new opportunities for prolonging the useful life of products by taking a user perspective on product circularity, especially by considering people's consumption processes (including the variety of consumption alternatives available and what these entail for people). To highlight alternative modes of consumption and provide an overview of the main options people have throughout the process, i.e. possible paths of consumption, a consumption cycle adapted for product circularity is proposed in Fig. 3.

The consumption cycle frames consumption from the users' point of view; instead of viewing consumption only as a use stage, preceded by marketing and sales and succeeded by end-of-life processes (which is commonly done in circular economy literature), Fig. 3 divides one person's consumption process into the three main phases *Obtainment*, *Use*, and *Riddance*. The figure deliberately excludes producers, providers, and other players, as they do not have to be involved in people's consumption processes (although they often are). Instead, different paths of obtaining, using, and ridding oneself of products are examined. These paths can be carried out by a single person, but also jointly by a household or a larger collective.

As illustrated in grey in Fig. 3, people can choose to obtain new products and dispose of them as trash in a linear fashion, but they can also choose to obtain and rid themselves of products through circular paths of consumption. They can pass on products in such a way that the products' parts or material can be recovered, and they can also salvage parts or materials as an alternative to buying new products. More importantly however, as illustrated in blue, they can obtain pre-used products and pass products on in such a way that they can be reused by someone else. These particular paths of consumption are grouped according to whether they influence people's ownership or access to a product, as this typically frames which paths are possible to carry out and/or are desirable to consider.

Ways to obtain ownership of pre-used products include buying, but also trading and receiving products as gifts. Ownership can be resigned by the corresponding paths (giving, trading and selling), but also by bringing products back to the provider. Products may be brought back to the provider for different reasons; people can return unused products, return defective products or bring back decayed products for product recovery. Ways to obtain access include leasing, subscribing, renting, borrowing, or co-using a product together with others. Such temporary access can be resigned by ending a lease or subscription contract, by returning rented or borrowed products and by ending co-use. Moreover, people can resign their access to owned products by offering someone else temporary access to the products. Apart from being used for their primary purpose, both owned and temporarily accessed products can be managed in different ways. This may include activities to maintain them in good condition and repair impairments, but also storing and moving the products.

The consumption cycle illustrated in Fig. 3 maps possible paths one user can take with regard to the three phases *Obtainment*, *Use*, and *Riddance*. It importantly also highlights that circular consumption loops require that products are transferred from user to user, i.e. that a product exchange takes place.

4.2. Exchange of products from use to use

The concept of product exchange concerns the transfer of

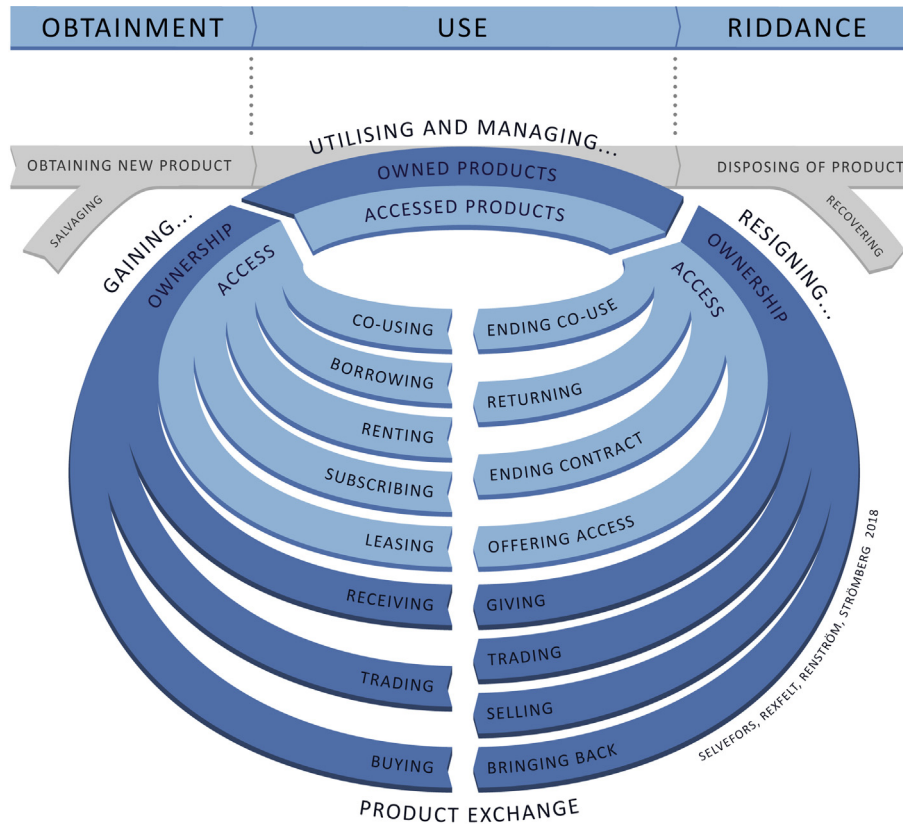


Fig. 3. The consumption cycle with examples of circular paths of consumption in relation to a linear consumption process.

ownership of, or access to, a product from one user to another, i.e. from Use to Use. It links the consumption processes of two persons, specifically one person's riddance process with another person's obtainment process. The exchange of a particular product between two users can be realised in many different ways depending on what paths of obtainment and riddance are considered possible and desirable by the users involved. The realisation of one particular path through the consumption cycle constitutes a *use-cycle*.

A product can go through multiple use-cycles before it reaches a decayed stage at which component or material recovery is the only

option, as illustrated in Fig. 4. A string of use-cycles in tight loops could increase both product utilisation and need fulfilment while reducing the resource throughput.

The loops between use-cycles illustrated in Fig. 4 could be accomplished directly between the users without any intermediary or through the involvement of exchange agents. As shown in Fig. 5, different types of exchange agents can facilitate or enable the exchange of products between users. Exchange agents can support the transfer, for instance by providing a channel through which people can connect and carry out the exchange or by temporarily

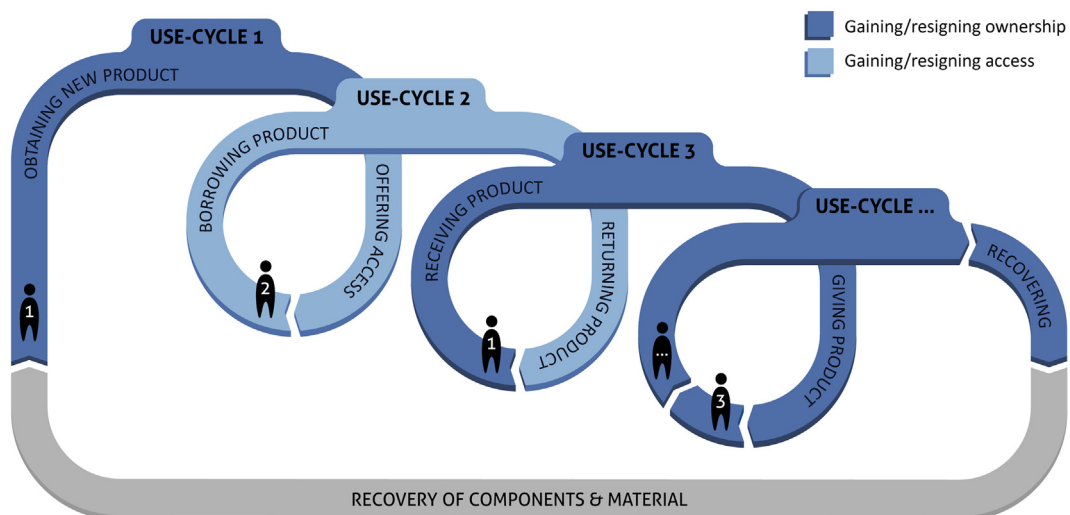
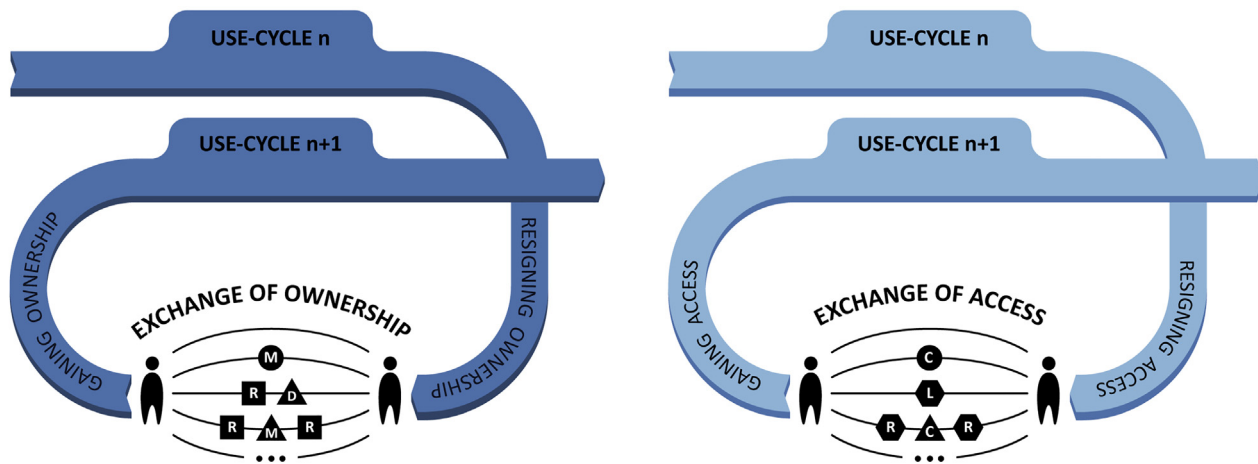


Fig. 4. Products can be circulated and used in multiple use-cycles before recovery of components and material is needed.



Exchange of ownership or access between users can be enabled by:

- exchange agents who facilitate exchange without gaining ownership, such as: ● C connectors, ● M mediators
- exchange agents who gain ownership temporarily, such as: ■ R retailers
- ⬠ exchange agents who maintain ownership and offer access, such as: ⬠ R renters, ⬠ L lenders
- ▲ exchange agents who support other agents, such as: ▲ C cleaners, ▲ M menders, ▲ D deliverers
- ⋯ other types of exchange agent(s)
- the users without involvement of any exchange agent

Fig. 5. Examples of how exchange agents can support the transfer of ownership or access between users.

taking over ownership and ensuring that the product is in good condition before it is transferred to a new user. Companies can thus take on many different roles for extending product lifetimes, some of which will be more relevant than others depending on the particular company.

5. Exploring use to use design opportunities

As highlighted in the previous sections, circular consumption processes necessitate new activities and decisions and also entail different everyday challenges compared to linear consumption processes. The practicalities and challenges that circularity entail may not only make people consider it inconvenient, time-consuming, or in other ways undesirable to transfer products from use to use, they can also contribute to disrupting a circular flow altogether. Addressing such aspects through design is thus essential in order to develop new products and services more fit for circular consumption. This section will discuss design opportunities to prolong product lifetimes and decrease the resource throughput that can be identified by taking people's consumption processes as a point of departure. Such a user perspective highlights four main design strategies that can be used to make circular consumption processes more attractive to people. These strategies have the potential to not only increase product utilisation but also people's need fulfilment.

The strategies address different types of challenges, point to a variety of design opportunities, and are, as illustrated in Fig. 6, related to the proposed circular consumption cycle in different ways. Just as in the current narrative based on the generic product life-cycle, a user perspective points to strategies related to the use phase. The strategy *Design for Extended Use* addresses challenges associated with a product's lowered utility, attractiveness, and need-fulfilment over time. The strategy *Design for Pre- and Post-Use*

has been less frequently discussed, but is also crucial from a user perspective since it addresses practicalities during the use phase that for instance are related to handling a (pre-used) product prior to and after use, and recognising that an unused product can be released to a new user. Apart from strategies related to the use phase, a user perspective also highlights the importance of facilitating people's obtainment and riddance processes, i.e. facilitating the process of product exchange. Practicalities that are related to assessing pre-used products and circular offers, carrying out an exchange, and communicating with other agents can also be addressed with the strategy *Design for Exchange*. In addition to addressing challenges and practicalities in relation to the different phases of the circular consumption process, particular challenges that arise when products are circulated through multiple use-cycles can also be addressed. Such challenges, for example those associated with diverse user needs, shortened use-cycles, and long product histories, can be tackled with the strategy *Design for Multiple Use-Cycles* to make each new circular consumption process relevant and attractive for people. These strategies will be described in more detail in sections 5.1–5.4, in which challenges and practicalities of circularity in everyday life will be taken as a basis for exemplifying design opportunities relevant from a user perspective. These are accompanied by examples of designs that help users overcome these challenges, in order to illustrate and embody the design opportunities. How the highlighted design opportunities relate to previous research will also be discussed.

5.1. Design for extended use

As commonly argued in the literature, one way to extend product lifetimes and reduce resource throughput without extra transaction costs is to prolong the use phase. An extended use phase is however associated with a number of challenges that may

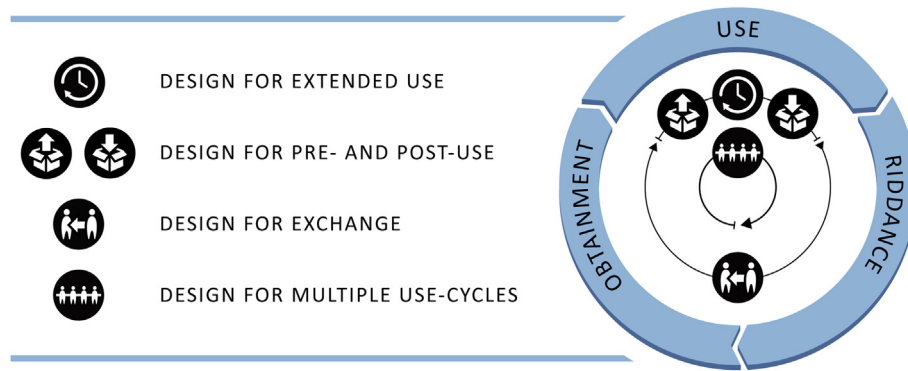


Fig. 6. Overview of the Use to Use design strategies in relation to the consumption cycle.

make people less prone to continue using a product for a prolonged time. Increased utilisation will result in an increased wear and tear, which may not only contribute to lowering the product utility over time but can also make the product less attractive to its user(s). Additionally, the product's utility, attractiveness, and potential to fulfil user needs may also decrease over time, for instance due to technological shifts and the emergence of new user needs, which can make people more inclined to obtain new products to replace a product they consider obsolete. To enable people to continue using a product for an extended period of time, and to make it more appealing to do so, the product (and any associated services) can be designed to tackle these challenges using the strategy *Design for Extended Use*. Fig. 7 highlights a number of ways in which challenges related to extended use can be addressed.

The design opportunities highlighted in Fig. 7 have already been extensively discussed in the literature and are generally considered to have the potential to contribute to prolonging specific use-cycles. Designing products so that they are reliable, physically durable, and aesthetically pleasing over time, and so that they can be repaired, maintained, and upgraded is commonly argued for (Bakker et al., 2014a,b; van der Berg and Bakker, 2015; Bocken et al., 2016; Cooper, 2005; Haug, 2016; Hebrok, 2014; den Hollander et al., 2017; Khan et al., 2018; Moreno et al., 2017; van Nes and Cramer, 2005). Although some papers (see e.g. Bakker et al., 2014a) highlight that not only manufacturers or service providers but also users can be involved in activities to repair, maintain, and upgrade products, most authors focus on how products can be designed to facilitate such activities as part of circular production processes and new services offers. Adapting products so that they become easy to repair, maintain and upgrade solely in an industry setting is problematic from a user perspective, since the design characteristics which would make it easier for users may be very different. Hence, when tailoring design opportunities to facilitate these types of activities in regard to a particular design, designers should not only consider production and business constraints but also whether users will take part in carrying out the activities.

Another opportunity commonly argued for in the literature is to increase the emotional durability of products so that people will care for them and want to keep them longer (Bakker et al., 2014a; Bocken et al., 2016; Chapman, 2016; Cooper, 2005; den Hollander et al., 2017; Moreno et al., 2017; van Nes and Cramer, 2005; Page, 2014). Although increased attachment can slow the resource throughput, it can also contribute to people holding on to products they do not need that could have been utilised by someone else (cf. Lehtonen, 2003). If products are designed for attachment regardless of whether people have long-term needs for the products or not, this tactic may reduce both product utilisation and need-fulfilment, resulting in a market pull for additional products. For

this reason, products such as children's clothes and wedding dresses should not be designed for attachment. Hence, from a circular consumption point of view it is vital that this tactic is only considered when the product can support people to satisfy needs over long periods of time. The importance of sustained need fulfilment is also highlighted in other papers that advocate flexible and adaptable products that can meet altering needs, offer variation, and evolve with people (van der Berg and Bakker, 2015; Chapman, 2016; Moreno et al., 2017; van Nes and Cramer, 2003).

5.2. Design for pre- and post-use

The challenges and opportunities discussed in 5.1 are not only relevant to address when aiming to prolong the use phase, they are also essential to consider when designing for circular consumption. People will find it less relevant to circulate products that have low utility, are unattractive, and can no longer be used to satisfy user needs. Apart from these challenges there are also additional aspects to consider when aiming to make circular consumption paths more preferable. From a user perspective it is crucial to also address the practicalities related to the required (and often undesirable) activities and decisions that circular consumption processes entail compared to linear processes. Some of these practicalities are associated with two sub-phases of the use phase: the pre- and post-use phases. The pre-use sub-phase is the initial stage of the use phase, which follows directly after the obtainment phase but prior to actual use of the product. The post-use sub-phase is the concluding stage of the use phase, which is initiated when the product is no longer used and precedes the riddance phase.

When considering these two sub-phases from a circular instead of a linear point of view some differences can be identified. Firstly, people need to handle pre-used products instead of newly produced products that have not been used by others. This has implications for what actions people have to take and how inconvenient or difficult these actions might be. For instance, when handling a pre-used product people may have to take additional actions to ensure that the product is clean, that it can be correctly installed, or that they have access to any information and instructions needed, which they normally do not need to do when obtaining a newly produced product. Secondly, when people are finished using the products they need to acknowledge that they should circulate them instead of simply storing them away or disposing of them without considering their potential future use. Fig. 8 lists a few ways to address these practicalities using the strategy *Design for Pre- and Post-Use*.

In comparison to design opportunities associated with the strategy *Design for Extended Use*, design opportunities to address practicalities related to the pre- and post-use sub-phases are less



Fig. 7. Examples of ways to enable extended product use and make this more appealing. Product and service examples provided by Abu Garcia (2018), Husqvarna (2018), Wibe ladders (2018), Nudie Jeans (2018), Skofabriken Kavat (2018), The Agency of Design (2018), and Didriksons (2018).

frequently discussed in the literature. Some papers do point out tactics that can be applied to ease the practicalities associated to these sub-phases, but they usually don't discuss them in relation to people's consumption processes. For instance, van der Berg and Bakker (2015) and Go et al. (2015) highlight opportunities to facilitate cleaning but only discuss these as a maintenance activity, not as an activity that people may have to do also before even using a pre-used product or before passing it on to someone else.

Designing for detachment has received much less attention in the literature than the opposite tactic designing for attachment, which was discussed in section 5.1. Since bonding with all products can be unwanted and considered a burden by people (Marchand and Walker, 2008; van Nes and Cramer, 2005), and since this may make people less prone to circulate products (Choi et al., 2017), designing for detachment can be a suitable tactic to apply in some cases. Encouraging people to reflect on whether or not they need a certain product and making it easier for people to emotionally let go of products that they no longer need can encourage tighter loops and increase utilisation and need-fulfilment, which can reduce the overall product throughput. Designing for detachment does not however exclude designing for attachment, both tactics can be considered in parallel and applied separately or in unison depending on the particular case (e.g. Choi et al., 2017). As an

example, a user can become attached to a rental service without becoming attached to its products. Thus, when designing for attachment and/or detachment, one can question what the user should be attached to and/or detached from. Is it the product, the benefits the product offers, the service or user community through which the product may be offered, or even the particular obtainment and riddance paths through which the user gains and resigns ownership or access?

5.3. Design for exchange

Apart from implications associated with the use phase, circular consumption also entails implications related to the obtainment and riddance processes. Obtaining and ridding oneself of a pre-used product via circular paths of consumption, instead of a linear process, will influence how people explore and reflect on options, identify suitable providers and offers, and decide how to rid themselves of products. Moreover, since a circular consumption process couples one person's obtainment process with another person's riddance process through product exchange, circular consumption often also necessitates new activities and decisions related to the exchange process. Such activities include how to properly assess a pre-used product and the overall offer, how to



Fig. 8. Examples of ways to facilitate the pre- and post-use sub-phases. Product and service examples provided by Evertsson & Johansson (2017), Tekniska museet (2017), Rebaudengo, Aprile & Hekkert (2012), and Vigga (2018).

carry out the exchange, and how to communicate with the current/next user and/or with any involved exchange agents. These types of activities and related practicalities may not only be undesirable but may also make the exchange process very challenging for the people involved.

Fig. 9 provides an overview of ways to address some of the practicalities associated with the exchange process for the strategy *Design for Exchange*. While the design opportunities previously highlighted in relation to the use phase focus primarily on challenges and practicalities in relation to a main user, designing for exchange involves considering activities and challenges in relation to two users (the current user and the next user), and sometimes also in relation to one or more exchange agents who facilitate or enable the exchange. This points to many opportunities to design products so that it becomes easier for people to circulate products from one user to another. For instance, flat-packed furniture can be designed so that it is easy to assemble the first time, but also easy to dismantle, convenient to transport to someone else, and easy to reassemble for the new user. The strategy also points to opportunities for exchange agents to offer services that take care of undesired activities associated with particular obtainment and riddance paths that have been identified to hinder people from resigning ownership and circulating their products.

Design opportunities to address practicalities related to the exchange process are seldom discussed in the literature. Although there are papers that point out opportunities, for instance to ease testing (van der Berg and Bakker, 2015; Go et al., 2015), disassembly and assembly (Bakker et al., 2014a; van der Berg and Bakker, 2015; Bocken et al., 2016; Go et al., 2015; Moreno et al., 2017), and

handling and transportation (van der Berg and Bakker, 2015; Go et al., 2015), these are primarily discussed in regard to how circular consumption processes and circular business initiatives can be made more efficient and profitable for companies. However, these tactics and other tactics can be applied to facilitate the exchange process from a user perspective, which has recently been explored in two Master's thesis projects at Chalmers University of Technology (Hagman and Wendt, 2018; Rosman, 2018). Only a few others have suggested strategies that address the transfer of products between users and use-cycles, but they provide little design guidance. For instance, den Hollander et al. (2017) discuss the strategy *Design for Recontextualising*, which frames changes in ownership as a way to reverse obsolescence, but they do not go into how products can be designed for easy recontextualisation.

5.4. Design for multiple use-cycles

Apart from the challenges and practicalities a person may experience and have to deal with during each phase of their own circular consumption process, circular consumption also brings about additional challenges when the number of use-cycles per product increases.

An increased number of use-cycles will increase the number of consecutive users, all of which will have different preconditions, expectations, and needs. Hence, need-fulfilment and a satisfying user experience should not only be ensured for the first user, but also for the 2nd, the 10th and maybe even the 100th user. When considering how the product should be designed to be useful not only for the first user but for multiple users throughout multiple

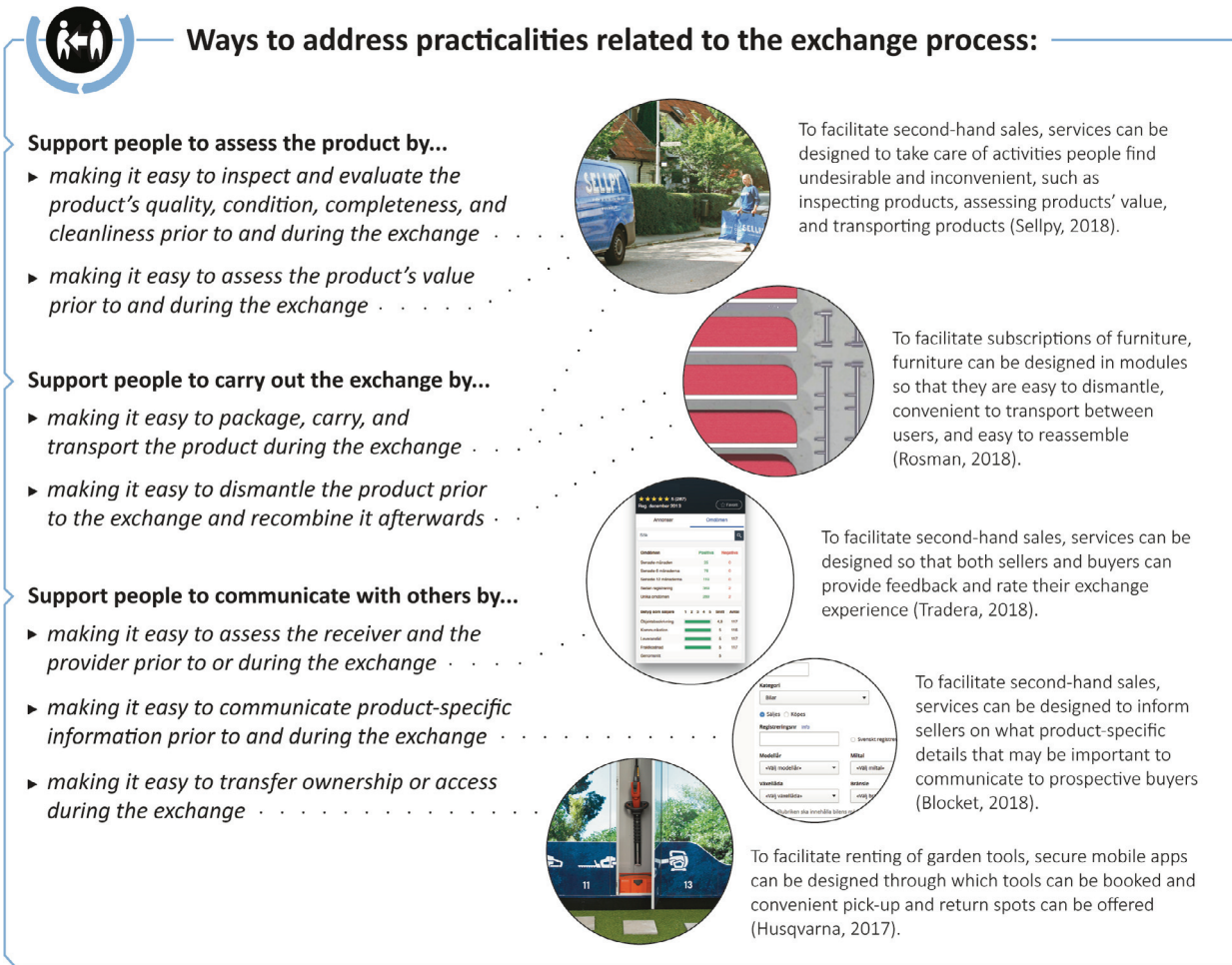


Fig. 9. Examples of ways to facilitate the exchange process. Product and service examples provided by Sellpy (2018), Rosman (2018), Tradera (2018), Blocket (2018), and Husqvarna (2018).

use-cycles, it becomes relevant to question which user need(s) it is designed for. Should it be designed to fit a particular need, cater for the multiple needs of future users, or be adaptable to needs that emerge across use-cycles?

Another challenge related to an increased number of use-cycles is the potential of shortened use-cycles. While this can be considered beneficial as it can increase the level of product utilisation, it will also change the demands placed on the product. If people only expect to use the product temporarily for a short period of time, or maybe even just once, the product must be very easy to understand and use since people will not spend a lot of time learning how to use the product and its functions, i.e. it must have high *guessability* and high *learnability* (for definitions, see Jordan, 1998).

An increased number of use-cycles, and thus an increased number of past users, will also increase the risk that future users will consider the history of a pre-used product to be a drawback. This may make them question and underestimate the product's condition, quality, and value to a larger extent compared to other alternatives, which in turn can make them less prone to obtain and use the product.

These types of challenges can be addressed through the strategy *Design for Multiple Use-Cycles*. Fig. 10 provides an overview of ways to tackle the challenges by both enabling multiple use-cycles and making them more appealing to people.

Many others also point to the necessity of designing flexible products that can be used to fulfil different needs or be adapted to

new needs and wants of different people (Moreno et al., 2017; van Nes and Cramer, 2005), and that products need to be adapted to the needs of new users along a chain of ownership (see e.g. Nissen et al., 2017). Although manufacturers or service providers can be responsible for adapting the products they offer, products can also be designed so that it becomes easy for future temporary users to modify the products themselves without any company involvement (cf. van Nes and Cramer, 2005). In order to make it easy for temporary users to both use and adapt products, tactics to increase a product's guessability and learnability can be applied. These tactics are frequently discussed in usability literature but should be given more attention in discussions related to product circularity.

Other tactics that should be given more attention include how to design products so that they can be transferred from use to use while maintaining high perceived value despite a long history of use and users. Baxter et al. (2017) argues that if physical and nonphysical elements of contamination are not addressed through design they will prevent people from circulating products. Undesirable physical traces of use can be addressed for example by facilitating cleaning or the removal of user settings. Undesirable nonphysical traces can be addressed for example by making it easy to remove personal information, and positive traces can be added, for instance by enhancing a product's value and history by augmenting its provenance (de Jode et al. 2012) or passing on past experiences and accumulated knowledge to build value for future users.

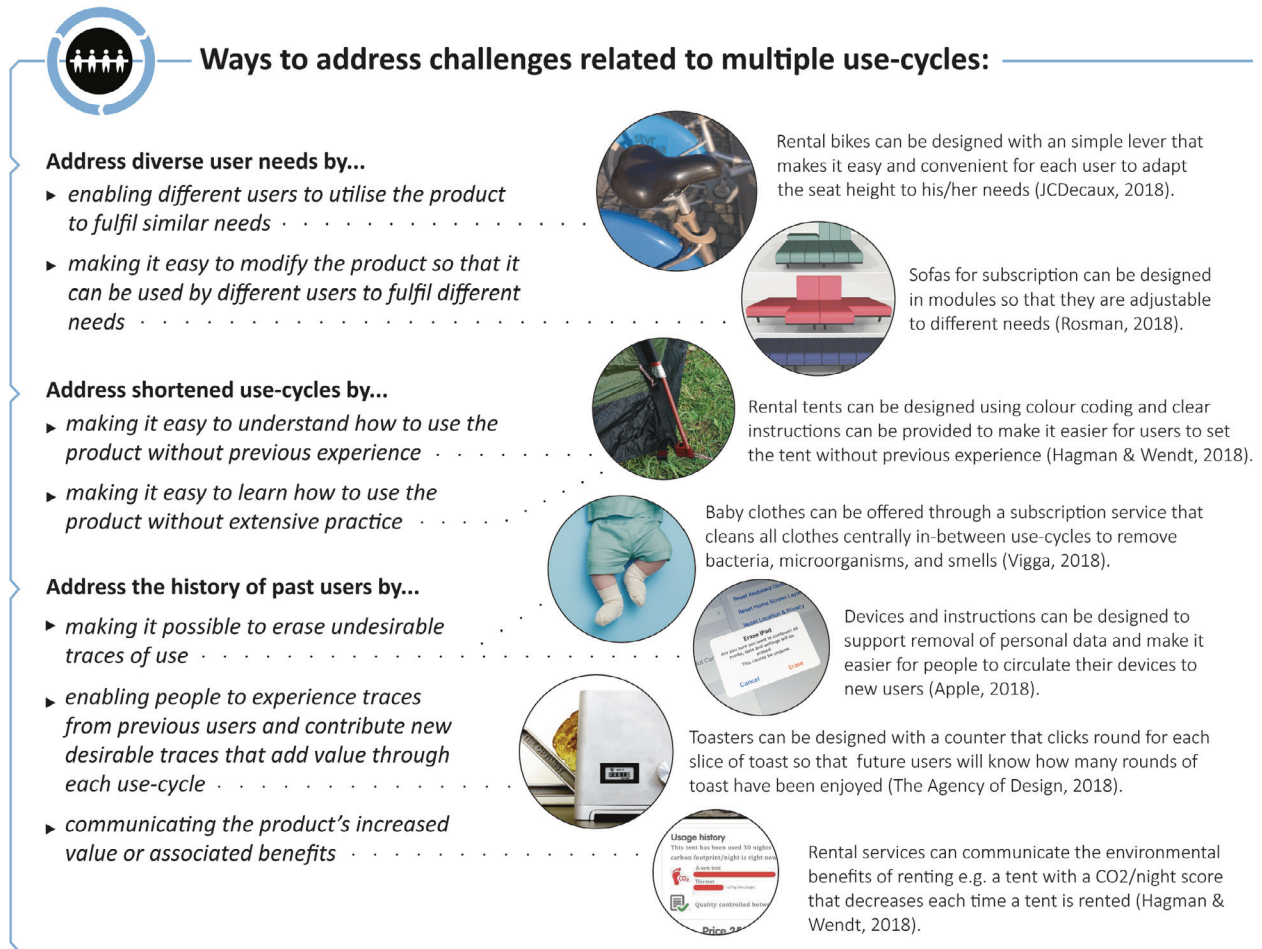


Fig. 10. Examples of ways to enable multiple use-cycles and make it more appealing to circulate products. Product and service examples provided by JCDecaux (2018), Rosman (2018), Hagman & Wendt (2018), Vigga (2018), Apple (2018), and The Agency of Design (2018).

6. Discussion

This paper introduces a user perspective as a complementary lens through which opportunities for product circularity can be explored. The overall contribution of such a perspective and its implications for extending product lifetimes and increasing utilisation will be discussed in this section, along with aspects that remain to be explored in more depth.

6.1. The link between product lifetimes and product utilisation

Extending product lifetimes by making the product continuously relevant for a single user is an important strategy to reduce resource use since “continued ownership is cost efficient: reuse, repair, remanufacture without a change of ownership saves double transactions costs.” (Webster, 2017, p. 83). However, circulating products may sometimes be a better option from a need-fulfilment and product utilisation point of view. Peoples' homes are filled with serviceable products that are not utilised as much as they could be, even though they in some cases stay relevant for their owner over a long period of time. Product lifetimes and product utilisation are thus connected concepts, since they are both needed in order to maximise need fulfilment with as low resource throughput as possible. They are also directly interrelated, since a product's lifetime (in calendar time) often depends on its utilisation. This is important, since it adds another factor to consider in relation to

product circularity. For instance, it is in principle more relevant to increase utilisation of products that predominantly deteriorate (or lose relevance in other ways) over time than products that predominantly deteriorate with use.

6.2. Implications of applying a user perspective

The user perspective presented in this paper has highlighted a number of user-related challenges and their interrelated design opportunities for either extending use or circulating products. While some of these design opportunities are common principles of good design, they are seldom discussed in regard to their importance to enable circular paths of consumption. For example, while it may often be advantageous to design a product so that it is easy to clean and intuitive to use, this will become even more important if the product is to be circulated among multiple users.

In addition to the discussed challenges and design opportunities, there are more general implications of the reframed narrative of product circularity. Table 1 summarises how the reframed narrative compares to the current one in regard to a number of key aspects.

As Table 1 shows, the user perspective presented in this paper views users as the nexus of product circularity, and focuses on issues of consumption instead of issues of production and business models. This in turn changes how the role of companies is viewed; they become enablers of circular consumption instead of circular

Table 1

A comparison between the current and the reframed narrative for product circularity.

Product circularity from a production and business model point of view	Product circularity from a user point of view
The product life-cycle as a point of departure.	People's consumption processes as a point of departure.
Companies as the nexus of circularity.	People as the nexus of circularity.
Consumption described as <i>Distribution, Use and End-of-life</i> .	Consumption described as <i>Obtainment, Use and Riddance</i> .
Circularity through resource recovery.	Circularity through product exchange.
Companies as providers of products and services fit for circular production.	Companies as providers of products and services that support and fit into circular consumption.
Companies as developers of circular business models.	Companies as exchange agents that can support people's circular consumption.

production. Hence, there is less focus on ensuring sustainable operations, and more on enabling people to live a sustainable life. In addition, this unveils a number of rationales for companies that may be less apparent from a production and business model point of view.

By not solely focusing on developing successful circular business models, companies can find other ways to support product circularity. For instance, if cleaning is required by the users prior to or after a use-cycle, this can be addressed by designing the product so that it is easy for the user to clean (or so that it does not get dirty in the first place), or by offering a cleaning service. Thus, a company that designs and manufactures products does not necessarily need to 'servitizise' to be an enabler of circular consumption. As an example, companies involved in designing and building new homes could adapt these so they are suitable for sharing, and fit with the business model of [AirBnB \(2018\)](#); they do not have to 'become the next AirbnB' themselves. A user-centric perspective on circularity entails reflecting on how the company can contribute to the consumers' processes, and not the other way around.

While some ways to support users to circulate products may not be considered to have any business value today, they might be essential tomorrow. For instance, designing products so that they become easier for users to sell on the second-hand market is not a priority among companies today, since it rarely makes the products more attractive when sold as new (apart from a few product categories such as cars and boats). However, in a future with fierce competition for resources, market forces may change this. If new products become significantly costlier to buy, more people might contemplate their future exchange already before buying them, which in turn can make companies designing for people's circular consumption processes more competitive.

Additionally, it needs to be acknowledged that a user perspective is but one of the lenses that a company may (and should) view product circularity through. While this paper argues for the benefits that a rather strict user perspective may entail, it does not argue that this should be the only perspective considered by a company. Although applying a user perspective may result in new insights about users, and novel ideas that could be attractive to people, companies need to ensure that these ideas are not disadvantageous, e.g. from a business or a sustainability perspective. These perspectives need to be considered as well, for instance by conducting business cases and life-cycle analyses. Just like in any process to bring about new products and services, user insights can be an important enabler of coming up with ideas for competitive solutions, or refining existing ones.

6.3. Use to use related aspects to explore in future research

While the presented user perspective provides new insights into product circularity, it also indicates some areas in need of further exploration. One central area is to generate an even more in-depth

understanding of the everyday practicalities of circular consumption. While this paper has explored this on a general level, a more specific understanding is needed when designing for circular consumption. Therefore, it is also important to develop and adapt user study methods so that they can support designers when mapping out the users' journeys throughout the consumption process, and associated practicalities. Traditional methods for user studies focus on exploring people's needs and use of products and services during the use phase, but these methods must be complemented with methodological support to study all three phases of consumption.

Another important aspect that needs further attention is how different types of products relate to the various consumption paths. While some products may be inherently more suited for certain paths, others may bring about undesirable user activities that can cause people to consider the same paths less attractive in particular situations and for particular products.

Lastly, the design strategies and associated design opportunities proposed in this paper need to be evaluated through application in design processes, in particular the less established ones.

7. Conclusions

To contribute to a more profound understanding of the practicalities of product circularity in everyday life, this paper has presented a user perspective on product circularity focused on people's consumption processes. This perspective describes consumption as a triphasic process (obtainment, use, and riddance) and also highlights the importance of product exchange, i.e. the transfer of products from use to use, as a crucial part of circular consumption processes. Since a circular consumption process entails different challenges and practical consequences in everyday life compared to a linear consumption process, applying a user perspective can aid the identification of new design opportunities to extend product lifetimes and increase product utilisation. This paper discusses four key strategies that can be used to design products and services fit for circular consumption: Design for Extended Use, Design for Pre- and Post-Use, Design for Exchange, and Design for Multiple Use-Cycles. Although some of the design opportunities associated with the strategies have been discussed previously in the literature, few papers discuss the opportunities from a user perspective.

The presented reframing of product circularity complements the current narrative, which in turn highlights rationales for companies that are less apparent in a production and business model narrative. In particular, it shows that companies do not have to develop business models with themselves as the nexus of circularity. Instead, they can develop products and services fit for circular consumption, or act as exchange agents, both of which enable products to be transferred from use to use.

To further the understanding of product circularity from a user perspective, additional studies are required that in more depth

explore challenges and practicalities related to people's circular consumption processes. Additionally, research that contributes to advancing user study methods is needed, as well as design projects that explore opportunities to develop products and services fit for circular consumption.

Declarations of interest

None.

Acknowledgements

The research was supported by the Kamprad Family Foundation for Entrepreneurship, Research & Charity, Sweden, grant ID: 20160136. The funding body was not involved in the conduct of the research or in the preparation of the article.

References

- Abu Garcia, 2018. Fishing gear manufacturer offering products with long-term performance. <http://www.abugarcia-fishing.co.uk/catalogue/index.html> accessed 2018-12-04.
- Ackermann, L., Mugge, R., Schoormans, J., 2017. Consumers' attitudes towards product care: an exploratory study of motivators, ability factors and triggers. In: Bakker, C., Mugge, R. (Eds.), *Product Lifetimes and the Environment 2017 Conference Proceedings*. IOS Press, Delft, The Netherlands, pp. 1–4.
- AirBnB, 2018. Online Hospitality Service. <https://www.airbnb.com/>. accessed 2018-12-04.
- Antonides, G., Van Raaij, W.F., 1998. *Consumer Behaviour: A European Perspective*. John Wiley & Sons Ltd, Chichester, England.
- Apple, 2018. Computer and Home Electronics Manufacturer. <https://support.apple.com/en-us/HT201351>. accessed 2018-12-04.
- Bakker, C., den Hollander, M., Van Hinte, E., Zijlstra, Y., 2014a. Products that Last: Product Design for Circular Business Models. TU Delft Library, Delft, the Netherlands.
- Bakker, C., Wang, F., Huisman, J., den Hollander, M., 2014b. Products that go round: exploring product life extension through design. *J. Clean. Prod.* 69, 10–16.
- Baxter, W., Aurisicchio, M., Childs, P., 2017. Contaminated interaction. Another barrier to circular material flows. *J. Ind. Ecol.* 21 (3), 507–516.
- van der Berg, M.R., Bakker, C., 2015. A product design framework for a circular economy. In: Cooper, T., Braithwaite, N., Moreno, M., Alavia, G. (Eds.), *Product Lifetimes and the Environment 2015 Conference Proceedings*. CADBE, Nottingham, UK, pp. 365–379.
- Blocket, 2018. Swedish Classified Advertisements Website. <https://www.blocket.se/>. accessed 2018-12-04.
- Bocken, N.M., de Pauw, I., Bakker, C., van der Grinten, B., 2016. Product design and business model strategies for a circular economy. *J. Ind. Prod. Eng.* 33 (5), 308–320.
- Botsman, R., Rogers, R., 2011. *What's Mine Is Yours: How Collaborative Consumption Is Changing the Way We Live*. HarperCollingPublishers, London, England.
- Brezet, H., Van Hemel, C., 1997. *Ecodesign: A Promising Approach to Sustainable Production and Consumption*. United Nations Environment Programme, Paris, France.
- Camacho-Otero, J., Pettersen, I.N., Boks, C., 2017. Consumer and user acceptance in the circular economy: what are researchers missing? In: Bakker, C., Mugge, R. (Eds.), *Product Lifetimes and the Environment 2017 Conference Proceedings*. IOS Press, Delft, The Netherlands, pp. 98–101.
- Camacho-Otero, J., Boks, C., Pettersen, I.N., 2018. Consumption in the circular economy: a literature review. *Sustainability* 10 (8), 2758.
- Chapman, J., 2016. Subject/object relationships and emotionally durable design. In: Chapman, J. (Ed.), *Longer Lasting Products*. Routledge, New York, USA, pp. 61–76.
- Choi, Y., Stevens, J., Brass, C., 2017. Carative factors to guide design development process for object-owner detachment in enabling an object's longevity. In: Bakker, C., Mugge, R. (Eds.), *Product Lifetimes and the Environment 2017 Conference Proceedings*. IOS Press, Delft, The Netherlands, pp. 84–88.
- Cooper, T., 2005. Slower consumption reflections on product life spans and the "throwaway society". *J. Ind. Ecol.* 9 (1–2), 51–67.
- Didriksons, 2018. Clothing Brand Offering Clothes with an Extend Size Function. <https://www.didriksons.com/en/kids>. accessed 2018-12-04.
- EEA, 2015. *The European Environment State and Outlook 2015*. Copenhagen, Denmark. <https://www.eea.europa.eu/soer-2015/about/about-soer-2015>. accessed 2017-11-15.
- Ellen MacArthur Foundation, 2013. *Towards the Circular Economy - Opportunities for the Consumer Goods Sector*. <https://www.ellenmacarthurfoundation.org/publications/towards-the-circular-economy-vol-2-opportunities-for-the-consumer-goods-sector>. accessed 2018-04-05.
- European Commission, 2014. *Towards a Circular Economy: A Zero Waste Programme for Europe*, COM(2014) 398 Final/2. Brussels, Belgium.
- Evertsson, L., Johansson, H., 2017. Utveckling av produkter för en mer hållbar konsumtion – konceptutveckling av tre produkttyper för anpassning till alternativa konsumtionsmodeller. (Development of product for sustainable consumption – adapting three product types for alternative consumption models) Thesis for the degree of Bachelor of Science. Chalmers University of Technology, Gothenburg, Sweden.
- Gallaud, D., Laperche, B., 2016. *Circular Economy, Industrial Ecology and Short Supply Chain*. Wiley Blackwell, London, United Kingdom.
- Gnanapragasam, A., Oguchi, M., Cole, C., Cooper, T., 2017. Consumer expectations of product lifetimes around the world: a review of global research findings and methods. In: Bakker, C., Mugge, R. (Eds.), *Product Lifetimes and the Environment 2017 Conference Proceedings*. IOS Press, Delft, The Netherlands, pp. 464–469.
- Go, T., Wahab, D.A., Hishamuddin, H., 2015. Multiple generation life-cycles for product sustainability: the way forward. *J. Clean. Prod.* 95, 16–29.
- Gruen, A., 2017. Design and the creation of meaningful consumption practices in access-based consumption. *J. Mark. Manag.* 33 (3–4), 226–243.
- Guilinan, J., 2010. Consumer durables replacement decision-making: an overview and research agenda. *Market. Lett.* 21 (2), 163–174.
- Hagman, E., Wendt, L., 2018. *Design for Exchange – Developing Guidelines and Exploring Opportunities to Design a Tent for Circularity*. Thesis for the Degree of Master of Science. Chalmers University of Technology, Gothenburg, Sweden.
- Haug, A., 2016. Design of resilient consumer products. In: Lloyd, P., Bohemia, E. (Eds.), *DRS 2016 Conference Proceedings*. Design Research Society, London, UK, pp. 3873–3888.
- Hebrok, M., 2014. Design for longevity: taking both the material and social aspects of product-life into account. *J. Des. Res.* 12 (3), 204–220.
- Hiort af Ornäs, V., Rexfelt, O., 2006. Functional sales from a consumer perspective. In: Friedman, K., Love, T., Corte-Real, E., Rust, C. (Eds.), *Wonderground – the Design Research Society International Conference 2006 Proceedings*. Lisbon, Portugal. Paper: 0309.
- den Hollander, M.C., Bakker, C.A., Hultink, E.J., 2017. Product design in a circular economy: development of a typology of key concepts and terms. *J. Ind. Ecol.* 21 (3), 517–525.
- Husqvarna, 2018. Garden Tool Manufacturer. <https://www.husqvarna.com/>. accessed 2018-12-04.
- Jacoby, J., Berning, C.K., Dietvorst, T.F., 1977. What about disposition? *J. Mark.* 41 (2), 22–28.
- JCDecaux, 2018. Outdoor Advertising Corporation. <https://www.jcdecaux.com/partners/supplying-self-service-bikes>. accessed 2018-12-04.
- Nudie Jeans, 2018. Jeans Manufacturer Selling Re-used Jeans. <https://www.nudiejeans.com/page/re-use>. accessed 2018-12-04.
- de Jode, M., Barthel, R., Rogers, J., Karpovich, A., Hudson-Smith, A., Quigley, M., Speed, C., 2012. Enhancing the 'Second-Hand' retail experience with digital object memories. In: *Proceedings of the 2012 ACM Conference on Ubiquitous Computing*. ACM, Pittsburgh, PA, USA, pp. 451–460.
- Jordan, P.W., 1998. *An Introduction to Usability*. Taylor and Francis, Bristol, PA.
- Skofabriken Kavát, 2018. Shoe Manufacturer Sometimes Offering Do-It-Yourself Events. <https://www.kavat.se>. accessed 2018-12-04.
- Khan, M.A., Mittal, S., West, S., Wuest, T., 2018. Review on upgradability – a product lifetime extension strategy in the context of product service systems. *J. Clean. Prod.* 204, 1154–1168.
- Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: an analysis of 114 definitions. *Resour. Conserv. Recycl.* 127, 221–232.
- Kuikka, F., Swenne, L., 2017. *Design Guidelines for Shared Cars. Development Of Design Guidelines for Human Machine Interfaces And User Experiences In Cars Designed for Carsharing*. Thesis for the Degree of Master of Science. Chalmers University of Technology, Gothenburg, Sweden.
- Wibe ladders, 2018. Ladder Manufacturer Offering Spare Parts Online. <http://www.wibeladders.com/ladders/spare-parts/>. accessed 2018-12-04.
- Lehtonen, T.-K., 2003. The domestication of new technologies as a set of trials. *J. Consum. Cult.* 3 (3), 363–385.
- Leismann, K., Schmitt, M., Rohn, H., Baedeker, C., 2013. Collaborative consumption: towards a resource-saving consumption culture. *Resources* 2 (3), 184–203.
- Lofthouse, V., Prendeville, S., 2017. Considering the user in the circular economy. In: Bakker, C., Mugge, R. (Eds.), *Product Lifetimes and the Environment 2017 Conference Proceedings*. IOS Press, Delft, The Netherlands, pp. 213–216.
- Lofthouse, V., Prendeville, S., 2018. Human-centred design of products and services for the circular economy – a review. *Des. J.* 1–26.
- Lucas, G., 2002. Disposability and dispossession in the twentieth century. *J. Mater. Cult.* 7 (1), 5–22.
- Marchand, A., Walker, S., 2008. Product development and responsible consumption: designing alternatives for sustainable lifestyles. *J. Clean. Prod.* 16 (11), 1163–1169.
- Moreno, M.A., Ponte, O., Charnley, F., 2017. Taxonomy of design strategies for a circular design tool. In: Bakker, C., Mugge, R. (Eds.), *Product Lifetimes and the Environment 2017 Conference Proceedings*. IOS Press, Delft, The Netherlands, pp. 275–279.
- Mugge, R., Safari, I., Balkenende, R., 2017. Is there a market for refurbished toothbrushes? An exploratory study on consumers' acceptance of refurbishment for different product categories. In: Bakker, C., Mugge, R. (Eds.), *Product Lifetimes and the Environment 2017 Conference Proceedings*. IOS Press, Delft, The Netherlands, pp. 293–297.
- Tekniska museet, 2017. *The Swedish National Museum of Science and Technology*, Photo: Peter Häll. <https://digitaltmuseum.se/021026360734/videobandspelare>.

- accessed 2018-12-04.
- van Nes, N., Cramer, J., 2003. Design strategies for the lifetime optimisation of products. *J. Sustain. Prod. Des.* 3 (3–4), 101–107.
- van Nes, N., Cramer, J., 2005. Influencing product lifetime through product design. *Bus. Strateg. Environ.* 14 (5), 286–299.
- Nissen, N.F., Schischke, K., Proske, M., Ballester, M., Lang, K.D., 2017. How modularity of electroic functions can lead to longer product lifetimes. In: Bakker, C., Mugge, R. (Eds.), *Product Lifetimes and the Environment 2017 Conference Proceedings*. IOS Press, Delft, The Netherlands, pp. 303–308.
- Page, T., 2014. Product attachment and replacement: implications for sustainable design. *Int. J. Sustain. Des.* 2 (3), 265–282.
- Philipson, N., Wallner, A., 2017. *Urbanears Modular – an Adaptable Headphone System to Extend Lifetime*. Thesis for the Degree of Master of Science. Chalmers University of Technology, Gothenburg, Sweden.
- Pigosso, D.C., Zanette, E.T., Guelere Filho, A., Ometto, A.R., Rozenfeld, H., 2010. Ecodesign methods focused on remanufacturing. *J. Clean. Prod.* 18 (1), 21–31.
- Piscicelli, L., Ludden, G.D., 2016. The potential of Design for Behaviour Change to foster the transition to a circular economy. In: Lloyd, P., Bohemia, E. (Eds.), *DRS 2016 Conference Proceedings*. Design Research Society, London, England, pp. 1305–1321.
- Rebaudengo, S., Aprile, W.A., Hekkert, P.P.M., 2012. Addicted products: a scenario of future interactions where products are addicted to being used. In: Brassett, J., McDonnell, J., Malpass, M. (Eds.), *Out of Control - Proceedings of the 8th International Conference on Design and Emotion*. London, UK, pp. 1–10.
- Rexfelt, O., Hiort af Ornäs, V., 2009. Consumer acceptance of product-service systems: designing for relative advantages and uncertainty reductions. *J. Manuf. Technol. Manag.* 20 (5), 674–699.
- De los Rios, I.C., Charnley, F.J., 2016. Skills and capabilities for a sustainable and circular economy: the changing role of design. *J. Clean. Prod.* 160, 109–122.
- Rosman, J., 2018. *A User Centered Approach to Circular Product Design – Proposing Guidelines and Using Them to Design Furniture as a Service*. Thesis for the Degree of Master of Science. Chalmers University of Technology, Gothenburg, Sweden.
- Sellpy, 2018. *Swedish Online Second-Hand Retailer*. <https://www.sellpy.se/>, accessed 2018-12-04.
- Selvefors, A., Rexfelt, O., Strömberg, H., Renström, S., 2018. Re-framing product circularity from a user perspective. In: Storni, C., Leahy, K., McMahon, M., Lloyd, P., Bohemia, E. (Eds.), *DRS 2018 Conference Proceedings*. Design Research Society, Limerick, Ireland, pp. 2044–2057.
- The Agency of Design, 2018. *Design Agency*. <https://agencyofdesign.co.uk/projects/>, accessed 2018-12-04.
- Tradera, 2018. *Scandinavian Online Auction Site*. <https://www.tradera.com/>, accessed 2018-12-04.
- United Nations, 2016. *Transforming Our World: the 2030 Agenda for Sustainable Development, A/RES/70/1*. United Nations Office, Geneva, Switzerland.
- Vigga, 2018. *A Maternity and Kid's Wear Brand Offered through a Circular Subscription Service*. <https://vigga.us/order-vigga>, accessed 2018-12-04.
- Wastling, T., Charnley, F., Moreno, M.A., 2018. Design for circular behaviour: considering users in a circular economy. *Sustainability* 10 (6), 1743.
- Webster, K., 2017. *The Circular Economy: A Wealth of Flows*. Ellen MacArthur Foundation Publishing.
- Welch, D., Keller, M., Mandich, G., 2017. Imagined futures of everyday life in the circular economy. *Interactions* 24 (2), 46–51.
- Wieser, H., Tröger, N., Hübner, R., 2015. The consumers' desired and expected product lifetimes. In: Cooper, T., Braithwaite, N., Moreno, M., Alavia, G. (Eds.), *Product Lifetimes and the Environment 2015 Conference Proceedings*. CADBE, Nottigham, UK, pp. 388–393.
- Young, G., 2017. Taking good care: investigating consumer attitudes to product maintenance. In: Bakker, C., Mugge, R. (Eds.), *Product Lifetimes and the Environment 2017 Conference Proceedings*. IOS Press, Delft, The Netherlands, pp. 442–445.