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Sustainable Fashion in a Circular Economy

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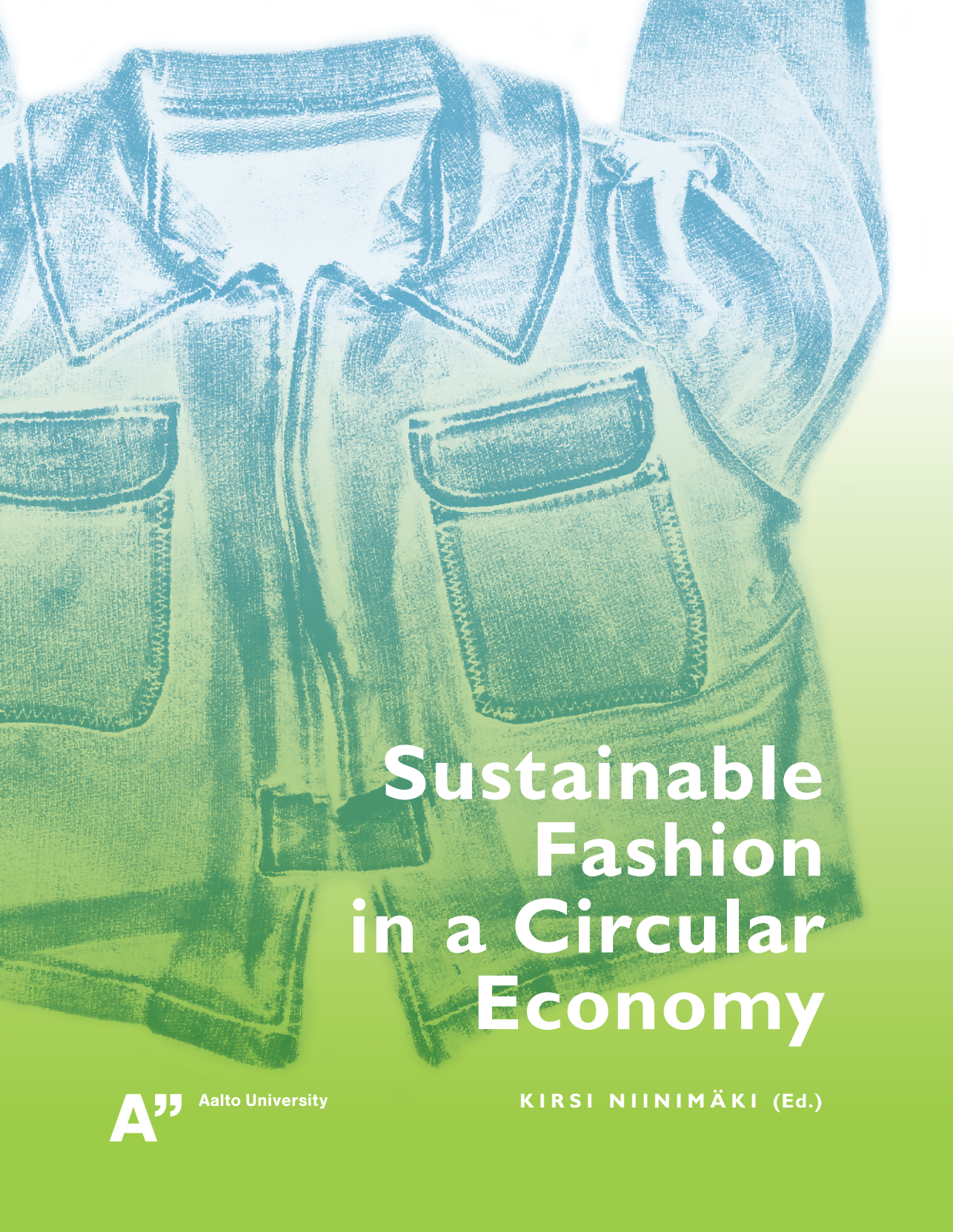
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Sustainable Fashion in a Circular Economy

A" Aalto University

KIRSI NIINIMÄKI (Ed.)

Sustainable Fashion in a Circular Economy

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KIRSI NIINIMÄKI (Ed.)

Aalto University
School of Arts, Design and Architecture

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Foreword

Circular economy (CE) is a hot topic. This publication will provide the most up-to-date information from the many levels of circularity within the fashion context. In Sector I Academic Ground, several international experts from the fields of design, consumption, business, technology explain how circularity can be approached in a multilevel way. The themes covered are sustainable fashion consumption, design strategies, new business thinking and textile waste. It is worth noticing that when talking about circular economy, waste is not the only focus. Other points to consider include the slowing down of consumption, constructing new design understanding and new business strategies. These are required for building the wider transformation of the fashion system, and, moreover slowing down the material throughput within the system, further to dealing with the end problem of textile waste.

The introductory chapter, *Sustainable Fashion in a Circular Economy*, written by the editor, opens the definition and describes some of the key elements and layers within the circular economy. This chapter closes with a design-guidelines for fashion in the CE context. The next chapter, *The Clothing Style Confidence Mindset in a Circular Economy* by Cosette M.J. Armstrong and Chunmin Lang, addresses an important layer in CE: consumer behavior and its meaning for CE. Writers approach the issue of sustainable consumption through the style

confidence of clothing, which has an impact on consumer purchasing and disposal behavior. The chapter *Collaborative Consumption and the Fashion Industry* by Claudia E. Henninger, Celina Jones, Rosy Boardman and Helen McCormick, focuses on interesting and emerging phenomena. It defines collaborative consumption and outlines the different activities at play within it, such as renting, sharing, swapping, and borrowing, and looks at how these activities are now entering the business world.

The next three chapters focus on the design side of CE. First, Ruud Balkenende and Conny Bakker provide the foundational principles with the text *Designing for a Circular Economy: Make, Use and Recover Products*. After which Essi Karel addresses the fashion designer's circular thinking through a case study, *Design for Circularity: The Case of circular fashion*. Ulla Ræbild and Karen Marie Hasling then provide a design tool to work with sustainability and circularity in an educational or business setting, *Sustainable Design Cards: A Learning Tool for Supporting Sustainable Design Strategies*.

Nancy M.P. Bocken, Karen Miller, Ilka Weissbrod, Maria Holgado and Steve Evans focus on business transformation in their text, *Slowing Resource Loops in the Clothing Industry through Circular Business Model Experimentation*. Based on a real life example, they describe how businesses can transform linear thinking towards circularity through a process of experimentation and how to further develop slow consumption as part of the business model. As Nancy M.P. Bocken et al. highlight business experimentations are needed to change the system from linear (take-make-dispose) towards circular one (**narrowing**=efficiency, **closing**=recycling, **slowing**=reuse, slow consumption, remanufacturing).

The last two chapters focus on textile waste. First, Kerli Kant Hvass describes the consumer viewpoint on textile disposal, and thereafter how to create solutions for the collection of textile waste in the chapter *A Consumer-centered Approach for Managing Post-consumer Textile Flows*. In the final chapter, *Review of Textile Recycling Ecosystem and a Case of Cotton* Pirjo Heikkilä, Paula Fontell, Marjo Määttänen and Ali Harlin focus on

textile waste and its recovery through different recycling technologies.

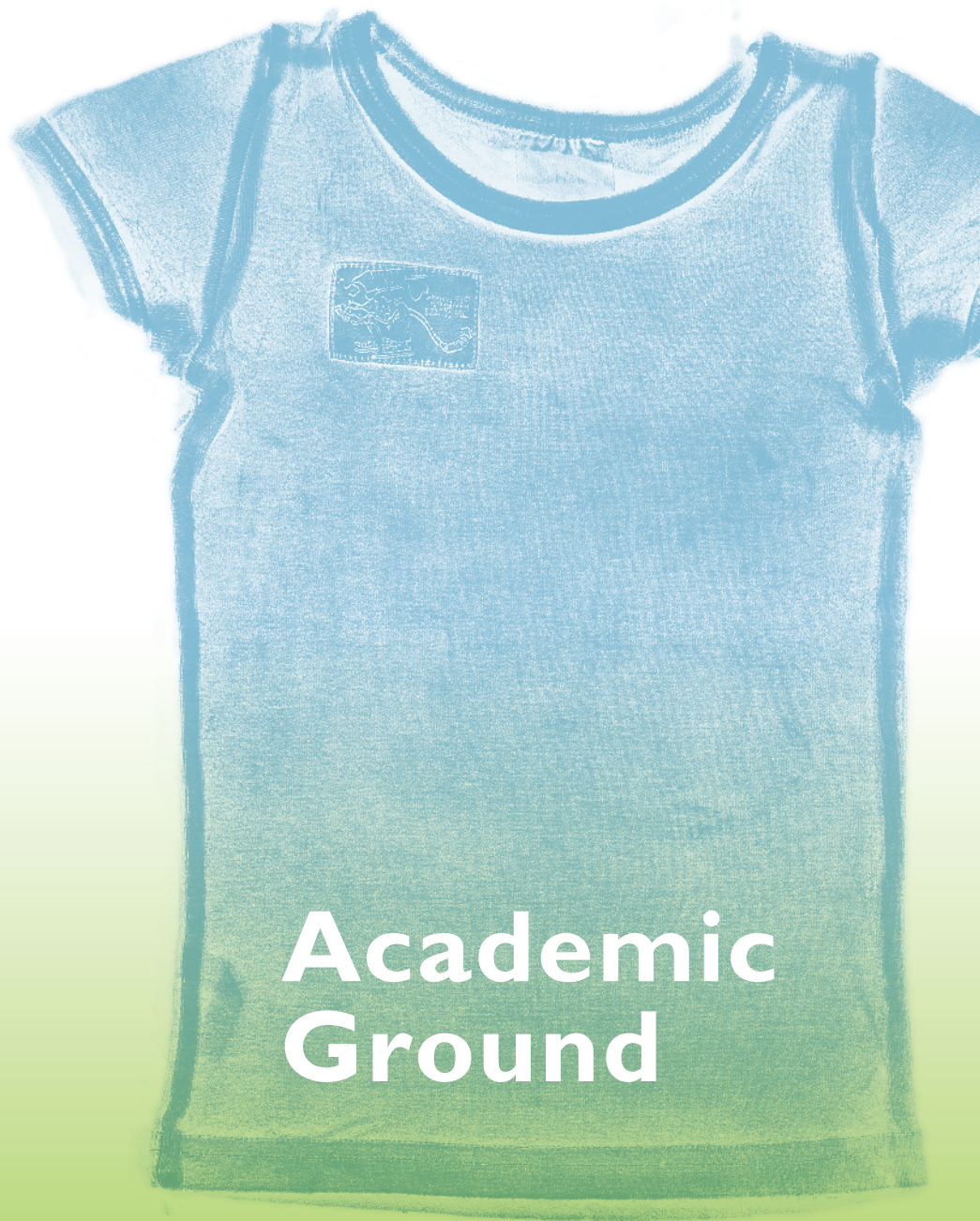
The sector II Business Examples presents some Finnish thinkers and businesses at the forefront of thinking about circularity. These cases incorporate the themes of services, recycling, creativity and collaboration and show the way to rethinking the fashion business in a CE context. Such bold thinkers and brave examples are needed to form a new understanding as to how to transform the current linear model towards circularity.

I want to thank all the writers for their time and efforts in sharing the latest knowledge from within the field. Special thanks go to academic reviewers for their valuable comments to improve the content and flow of the texts in the part I Academic ground. Thanks also extend to all the businesses presented in this book.

And for the reader, I hope you will enjoy reading this book and find it informative. Its aim is to open up circularity and its many levels of application within the fashion context. The field of circularity is emerging and new knowledge is currently entering the field. This book and its content can be understood as an entry point to this challenging new field. Learning and the construction of knowledge is ongoing.

Rotterdam 15.5.2018

Kirsi Niinimäki



**Academic
Ground**

Circularity and Fashion

D | Sustainable Fashion in a Circular Economy

Kirsi Niinimäki

This chapter provides an overview of the circular economy in general and specifically linking circular economy to fashion. While the phenomenon, fashion in a circular economy, is new and emerging, this chapter is an initiative to open some of its many layers, while not providing exact scientific knowledge as such. More so, it tries to show the complexity of this term while also providing some opportunities to change our linear way of thinking towards circularity.

Keywords: Circular economy, circularity, sustainable fashion, closed-loop, systems thinking



VERTAISARVIOITU
KOLLEGIALT GRANSKAD
PEER-REVIEWED
www.tsv.fi/tunnus

Introduction to current reality, linear economy

The textile and fashion industry is one of the largest industrial sectors, which uses a lot of resources and causes a lot of environmental problems. To give an example, globally 20% of industrial water pollution is caused because of the dyeing and treatment of textiles (Kant 2012, cited by EMF 2017, 21). In the linear system this industrial sector uses mostly non-renewable resources “– 98 million tons in total per year – including oil to produce synthetic fibers, fertilisers to grow cotton, and chemicals to produce, dye, and finish fibers and textiles” (EMF 2017, 20). While textile and fashion manufacturing has moved to lower-cost countries on the other side of the globe, so also have many environmental problems. The true value of resources used in industrial production are easily forgotten or subsidized (e.g. clean water, energy, pure soil) and the costs of environmental impacts are not included in the end price of the product. In this way low cost garments can have a remarkable environmental impact in the location where they are produced. Textile manufacturing in particular causes a lot of environmental problems, while harmful and toxic chemicals are used and waste is not treated properly. This causes human tragedies for workers and the neighbouring communities and their environment.

In the linear system (design-manufacturing-sale-dispose) we are wasting valuable materials in huge amounts. Not only materials, however, but also many other resources, for example water and energy needed for manufacturing are wasted if the product life-time is very short. It has been estimated that 80% of all products turn into “waste” and are thrown away within the six first months (Baker-Brown 2017, 11). Garments’ life cycles have also drastically shortened. For example, in the UK, WRAP (2012) has studied that the average time of owning a garment is 2,2 years. On the other hand the amount of impulse-purchased garments has increased, and these kinds of garments might never have been worn (Niinimäki 2011). A study from Finland showed that around 30% of garment purchasing was based on impulse shopping

(ibid.). Some consumers actively seek emotional “highs” by constant purchasing, and this emotionally “addictive” search easily leads to impulse shopping, which seems to have become accepted behaviour in today’s fashion consumption (Niinimäki 2018b). The average number of times a garment is worn has decreased by 36% compared to the situation 15 years ago (EMF 2017). Moreover, the vast amount of garment production results in markets being oversaturated, and not all garments produced actually enter the market anymore. There are different figures for unsold garments, but one estimation shows that even 20% of produced garments will be unsold (Ann Runnel 11.10.2017). For example, in the Netherlands it is estimated that 21 million garments were unsold in 2015, meaning 6,5% of garment offerings (Pijpker 5.5.2018).

WRAP (2012) has produced good reports on clothing consumption in the UK. They have reported that 1.14 million tons of clothes are supplied onto the UK market each year and 1.78 million tons of raw materials are needed to produce these items. From this, around one third becomes waste in the production phase (pre-consumer waste), 10 000 tons ends up as waste during the use time (damaged in the maintenance, e.g. during laundering) and 1.13 million tons ends its life either in re-use (540,000 tons, of which 70% goes overseas), recycled (160,000 tons), incinerated (80,000 tons) or goes to landfill (350,000 tons, worth £140 million).

In the linear model, the material throughput in the system is fast (fast design and manufacturing, fast consumption, easy disposal) and this fast tempo is also setting the model for the fashion business and its means of pursuing profit. McAfee et al. (2004) highlight that garments are not made to last for long in the current linear system and most of our garments are designed to be laundered only 10 times. Such is the new “norm” in the fast fashion business. But we also have other problems than waste in the fashion sector. There are consumers who buy new fashion items every week (Morgan & Birtwistle 2009) and fashion has become easy entertainment or a kind of fashion “hunt” for some consumers (see Armstrong et al. 2015, Niinimäki 2018b). Because of this intensive consumption and impulse purchasing our wardrobes

are full, and therefore many garments in our wardrobes are not in active use. Around 30% of clothing in wardrobes have not been worn for at least a year, according to a study by WRAP (2012), and Fletcher (2008) further estimates that up to 70% of our wardrobe content is in inactive use. This ends up as a huge unused resource and wardrobes full of disused garments.

While the linear model results in an oversaturated and oversized fashion system with big environmental impact (Armstrong et al. 2016), it is imperative that we develop better use of resources and change the system. We have to create a better balance and use all resources more wisely. Closing the loop and building a new understanding of how fashion can be redesigned in the context of a circular economy and can be more sustainable is the goal of this chapter.

Circular economy

A Circular Economy (CE) is regenerative by nature, based on principles of closed loops. A Circular Economy CE, is not a new concept. It originates from Walter Stahel's report "The potential for substituting manpower for energy" from 1976, presented to the European Commission (Baker-Brown 2017, 10). It presented the idea of an 'economy in loops', with the positive impact to increase jobs: "economic competitiveness, reduced dependence on natural resources and the prevention of waste" (ibid.). This idea was further developed by McDonough and Braungart in their concept 'Cradle to Cradle' which is a well-known principle for closing the loop in two different cycles; biological or technological (2002). According to this principle, a product is designed to have multiple life cycles or to be biodegradable. Accordingly, after the use phase, the product will continue in technical or biological cycle.

A biological cycle means composting, which, however, is not a realistic option for textiles while only a few fibers can be composted and while textiles include harmful chemicals which should not be released into the soil. Moreover, composting produces methane, which

contributes to greater greenhouse gas emissions and global warming (Niinimäki 2013), and even the nutrient value from textiles to soil is low. Furthermore, textiles, even bio-based, compost too slowly to be suitable in the municipal composting system and therefore should be composted in home-composting units. In the fashion sector, therefore, closing the loop is more likely to happen in a technical cycle (using textile waste to produce new fibers and yarns). Nonetheless, some of the latest experiments reveal the potential for using the biological cycle as one solution in the textile sector. For example, some Cradle to Cradle Certified garments have been developed to be compostable (see EMF 2017). On the other hand, a more interesting option is to combine these two cycles and use biological processes to some extent in order to process textile waste to be suitable for the next round of manufacturing within the technical cycle (producing new yarns). For example, while separating fibers in blended materials, biological composting can help, for example, to destroy bio-based materials from blends, and in this way polyester can be separated and used again in the recycling process (Yao 22.3.2018).

A circular economy approach in fashion aims to develop a more sustainable and closed-loop system where the goal is to extend the use-time of garments and maintain the value of the products and materials as long as possible. This means that all materials will be recycled in several rounds. Products are designed to be included in a system where all aspects support circularity. The original design needs to take account of several lifecycles. Materials need to flow within the system and waste needs to be collected and appreciated as a valuable material for recycling and material recovering. All products need to be collected back after their useful time is over. Policy measures could push the development towards this path by implementing Extended Producer Responsibility EPR principles (e.g. Niinimäki 2013; OECD 2001). Accordingly, moving towards a circular economy means taking a system perspective on fashion, where all actors are included: designers, producers, manufacturers, suppliers, business people and even consumers. A good model for the fashion sector is presented in Figure 1. This model was constructed by RSA (Royal Society for the Encouragement of Arts, Manufactures

and Commerce, “Great Recovery” programme 2013). The model constructs a four level system. The first includes consumer behaviour, and its goal is to extend the product use phase. The second includes companies and new kinds of business models (e.g. Product-Service Systems PSS) to extend or intensify the use of products. The third challenges manufacturers by bringing in new ways to extend the use-time of the product through remanufacturing. The fourth level concentrates on material recovery, using waste to manufacture new fibers and yarns. This is the most interesting level, and a lot of new development work is going on in this sector looking at how to use textile waste as a source for new fiber production. Notably, this model also includes key stakeholders who are needed to enact the transformation towards circularity. New kinds of collaborations are needed to get everyone onboard. Designers, researchers, industry, companies, users and policy makers are all needed to create a new network and a new system.

The next section presents the key concepts for circular economy. The text includes some business examples in parentheses, from businesses which have succeeded in offering some interesting developments relating to a certain aspect of CE.

Focus on use

As Walter Stahel puts it, the optimization of use or utilization of manufactured objects, is at the core of the circular economy, and not the term ‘cycle’ as one might have expected. This distinguishes the circular economy from the linear economy, which optimizes the production of the same objects up to the point of sale” (2017, wiii). Extending and intensifying the use, reusing the same object in a new context, and innovative reuse are some of the ways that shift use to the centre of circular thinking. This is a new challenge for industry, business and designers, but also for consumers, who need to critically consider their own consumption practices. We have to create a new consciousness towards the use of clothing and introduce new practices for using our clothing

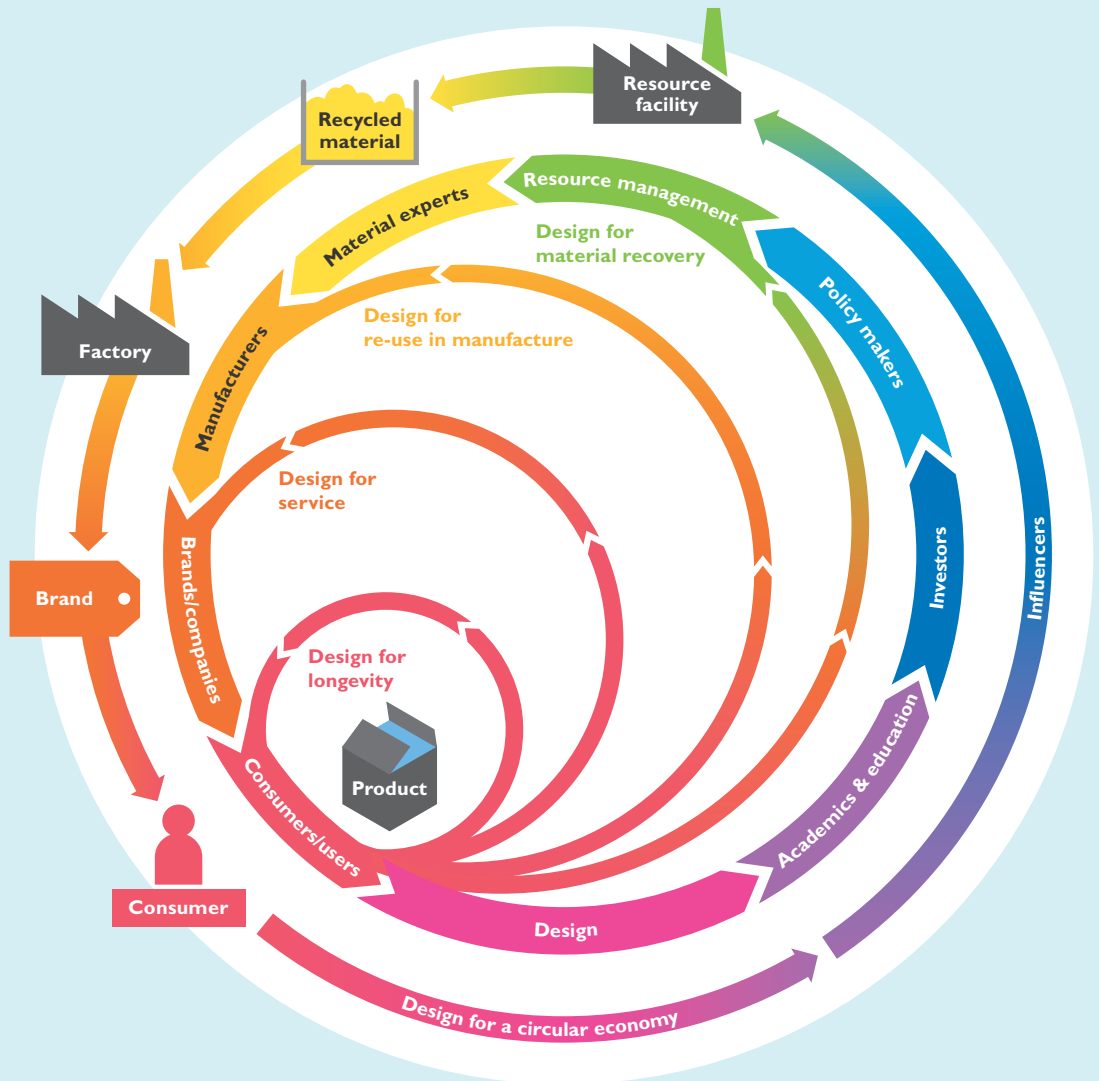


Figure 1. The Four Models of DCE, Design in a Circular Economy (RSA 2016).

longer, maintaining it well, but also investing in a smaller wardrobe with less content. The concept of a curated wardrobe is based on the need for wiser purchase decisions whereby each garment is seen as an investment, and thus wardrobe content is constructed slowly (e.g. Filippa K). The smaller content but smarter collection of clothing choices in a wardrobe provides an alternative approach to fast fashion consumption.

New business thinking

Extending the use of clothes is one key issue in sustainable development. For example, if we can double the use-time of clothing we can halve the resources needed for production and halve the waste rates of consumption (Stahel 2017). This would be an important improvement upon current unsustainable fashion consumption and the early disposal of clothing. Some examples already exist of how garments can be rented or leased (e.g. Mud jeans, Lena fashion library, Vaatepuu) or brands that offer free mending services to extend the use-time of garments and, simultaneously, to emotionally satisfy customers but also to strengthen brand value (e.g. Nudie jeans). Patagonia even offers returns with an ‘Iron Clad Guarantee’, offering a replacement or mending service if a product does not last as long as expected (EMF 2017). Product-Service-System PSS models can provide a new focus for fashion companies. Here, the focus is more on use and product utilization than on selling the product. Such services create the possibility of providing new value propositions for consumers. For example, through a more individual, customized or made-to-measure design service a better fit – for both mind and body – can be provided (e.g. Anna Ruohonen).

Circular economy means adopting a new, more strategic and future-oriented mindset in all aspects of a company’s activity. While in the linear model it is easier to focus on a narrow core, in a circular economy the core has to be in the lifecycle, use, and regeneration of products and closing the material loop:

Sourcing from return chains, growing presence in used product markets, creating value from any waste materials along the value chain and maintaining deep involvement with products in use are just some of the strategic shifts companies make to evolve to a circular model. Companies have to think beyond the traditional core and build an ecosystem of partners that operate and monetize the entire product lifecycle (Lacy & Rutqvist 2015, 149).

Enabling technology and grass root activities

Information technology, IT, provides us with new ways to track the origin and flow of material (Webster 2017). Transparency – the origin of the product – could be increased through the help of new technology. RFID codes (or yarn including the same information) could include information about the fiber content of the garment and could also inform about suitable recycling technology for the garment and its materials (EMF 2017).

Online services can provide possibilities to open out the production path behind the garment towards consumers (e.g. MADE-BY). Cloud services can also help the producer to make the right sustainable choices along the way. For example, *makersite.net* provides tools for teams to work with sustainability issues along the production chain and to calculate the best choices through LCA (life cycle analysis).

Reverse Resources (2017) has constructed a future view for the mass manufacturing garment industry and propose an open data system for all material leftovers. If this is done together with an alternative pricing system, factories could facilitate virtual traceability of material resources and create “virtual interconnections throughout the supply chain. ... This is crucial for building an effective circular economy as well as supporting many digital solutions of industry 4.0 globally (e.g. blockchain-based transparency)” (ibid., 22).

IT also provides new ways to reach the consumer and do business by engaging consumers. Crowdfunding could be one way towards



Figure 2. Swapping events organized by students in Aalto University, Helsinki (posters by Manuel Arias Barrantes).

sustainable fashion. Through crowdfunding, users can invest in a project they want to see implemented and the process aided by social media platforms (Kretschmer 2013, 186). Designers can sell a small collection, for example, specially made from sustainable and high quality, durable materials and produced locally. Through a crowdfunding campaign, a designer can sell the collection before it is produced, thereby avoiding surplus production (Anna Ruohonen has used this strategy). This ensures and stabilises the way of doing business. Crowdfunding also provides a channel for cooperation between designers/companies and users and thus can open “a shorter and more regional value chain” (Kretschmer 2013, 186) within the global and complex fashion system, which is otherwise not easy to control.

As Webster points out (2017, 103), “a circular economy is not primarily about technical materials and recycling/recovering them while moving to renewables. It is a different way to see the economy which includes the material but is not limited by it.” All kinds of activities are welcome in a circular economy and grass root activities can be influential or at least offer alternative business examples. A sharing economy can include activities like cooperation, sharing, flexibility, lending, giving, and gifting. For example, new IT enables services/platforms to be built, which can be used by anyone to provide repair or swapping services. A sharing economy can lead to collaborative consumption enabling consumer-to-consumer activities (see Figure 2 of a swapping event as a student activity in Aalto University). Peer-to-peer-based activities can provide new ways to access goods or services or can offer a platform for a business in second-hand garments, for example. This ‘two-sided market’ between consumers is happening through platforms created and run by third parties (Webster 2017; Hamari et al. 2015). Examples of this are the websites Zadaa and Emmy, where anyone can sell their garments.

Technologies can even create social interaction around these activities. Through the help of IT, a community can be built in which new forms of collaboration can happen, even face-to-face. Good examples of this are mending or knitting clubs. These communities can educate consumers to extend the use time of garments but can also enhance social wellbeing, providing emotional satisfaction which can even replace some of the emotional effects of fast fashion consumption (Hirscher et al. 2018). ICT examples lead to new ways of developing a sharing economy and also demonstrate ways towards a new kind of business thinking. As Webster (2017, 106) highlights: “The IT revolution is enabling circularity and the rethinking of materials, energy and credit flows. It is also one key to rebuilding social capital, social networks.” It also provides opportunities to act and operate on different scales (local, block-based) or combine different actors (e.g. companies and consumers) in a new kind of collaboration showing new alternatives for large business operations.

Dealing with and recovering waste

Lacy and Rutqvist (2015, 119) divide waste into four different categories. The first is **wasted resources**, where all materials and also energy are entirely lost if the product cannot be continually regenerated. The second is **wasted lifecycles**, where products have artificially short lifecycles, and might even be disposed while they are still functional; a phenomenon called early disposal. The third category is **wasted capacity**, where the full potential of the product is not used, seldom use for example. The fourth category is the **wasted embedded values**, where all resources and materials from the disposed product are not recovered and put back into use.

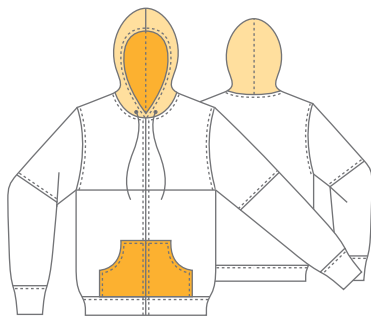
There exists a lot of both pre- and post-consumer textile waste, as explained earlier in this chapter. Reverse Resources (2017) found out that up to 25–30% of textile material is lost from the supply chain during fabric and garment production. This pre-consumer waste is mainly from cutting and mill waste and does not include the larger leftover materials (deadstock) from when the production season is changing. Reverse Resources have created a totally new way of using larger leftover pieces of fabric from the range of 18 inches to 5 yards as well as introducing deadstock fabrics back into mass scale production. This new strategy of using leftovers is a creative example of remanufacturing (the process of using leftover fabrics in mass-production). They approach the problem through three different design strategies. Firstly, **invisible remanufacturing**, where leftover fabrics are placed in internal sections (hidden details). Secondly, **visible remanufacturing**, where leftover fabrics are placed on external sections of a garment (visible details). Thirdly, **design led manufacturing**, where a designer takes into account a specific waste stream and uses that while designing a new garment. Here, the waste fabric has a strong influence on the aesthetic of the new garment (Runnel et al. 2017). This approach does not need big investment in technology but challenges the current way of designing and manufacturing on a mass-industrial scale. As Reverse Resources

highlight (ibid. 2017, 16), “remanufacturing is particularly interesting because it could be the key to creating the economic incentive for transparency. ... But making data on leftovers and creating transparency is the critical key to unlock effective circularity of material flows.”

Post-consumer waste can be recycled using mechanical, thermal or chemical recycling methods (see chapter 9). In mechanical recycling, material is selected, cut, shred, carded and spun into new yarns (e.g. Reblend, Purewaste). With this process, the quality of the yarn is not as high as with virgin materials and very often some virgin materials are added to keep the quality sufficiently high. Through the chemical or thermal recycling process, the material is returned to polymer level by dissolving it, and thereafter the fiber is regenerated (or reproduced). Unfortunately, a lot of recycling is down-cycling, meaning that the value of the material is lost (at least at some level) if the recycled material or

VISIBLE REMANUFACTURING

– using leftover fabrics on external sections of a garment



PRODUCTION OF 10 000 OF THESE HOODIES WOULD:

- Save 2843 yards (17%) of virgin fabrics
- Avoid 0.88 tonnes of fabrics from being spilled
- Saved 7827 kg CO₂

Hoodie specification drawing & marker plan

- Visible remanufactured fabric pieces
- Invisible remanufactured fabric pieces
- Virgin fabric
- Amount of saved virgin fabric

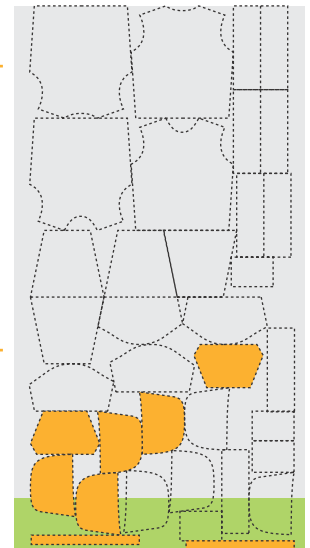
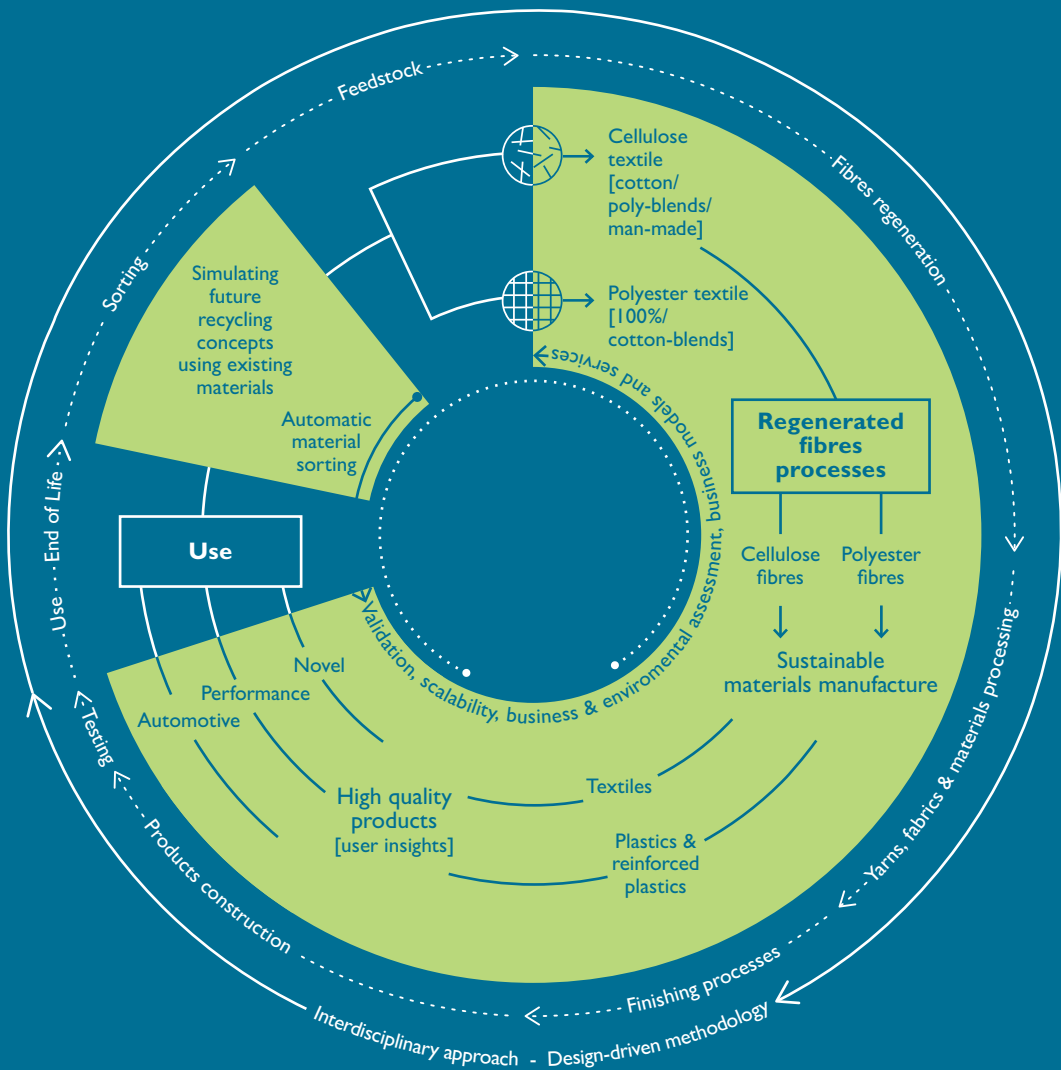


Figure 3. Visible remanufacturing by Reverse Resources (Runnel et al. 2017, 15).

product is of a lower value than the original (every frequently-recycled textile material is down cycled for filling purposes only). Recently, a lot of development work has been done to construct different technologies to be used with different waste fibers in the mechanical or chemical recycling process. New technical and system innovations are needed to use the waste as a valuable resource within manufacturing. New material standards and testing methods are also needed as more and more waste is remanufactured into new fibers, yarns, textiles and clothing. Safety issues are critical when textile waste material includes different kinds of chemicals, some quite harmful. In addition, new inventions are needed to totally close the loop and to recycle not only materials but also the chemicals in the textile materials.

A good example of multi- or even interdisciplinary collaboration is the T2C Trash-to-Cash project, by which new material and product opportunities are developed via creative design from textile waste or process by-products. With collaboration between 18 diverse partners from 10 different countries – from design research, material science, market research, and industry – this Horizon 2020 funded project aims to reduce the utilization of virgin materials, improve material efficiency, decrease landfill volumes and energy consumption, and foster design for recycling with the vision of closing material loops. The waste used in T2C is cotton, polyester, cotton-polyester blends and recycled paper board, and the aim is to develop technical innovations to make use of these waste streams while producing high quality materials and innovative design products. The project is based on wide collaboration between different knowledge areas, and the focus is to challenge the current linear system towards circularity. The project is based on three iterative cycles throughout the 3,5 years and on open knowledge

Figure 4. Closing the material loop. Green lines present the research areas in T2C project. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 646226.



TRASH
2
CASH



sharing between disciplines. At the end, product design concepts and prototypes are constructed in a co-design setting and are evaluated through the following aspects: circularity, LCA, and innovation potential (see the results from <https://www.trash2cashproject.eu/>).

One technology used in T2C is Ioncell-F, which is a chemical recycling method for cellulose fibers (Sixta et al. 2015; Aalto University 27.10.2015). The process uses environmentally friendly ionic liquid, which is an alternative to the solvents currently used in man-made cellulosic processes (viscose production). Ioncell-F technology converts wood into textiles or textile waste or paper waste into new fibers. It is an alternative to virgin cotton production or viscose production. In addition, the process has the potential to revolutionize recycling of textile waste, turning waste cotton into upcycled high-quality, high-end fiber.

Aalto ARTS contributes to the project through the development of design methods for interdisciplinary collaboration, defining new material attributes and making the first prototypes with recycled yarns, defining principles for design-for-recycling and constructing a methodology for a design-driven material innovation process. (For interim results, see, Smirnova et al. 2016; Niinimäki, Tanttu, & Kohtala 2017; Niinimäki, Tanttu, & Smirnova 2017; Tanttu, Kohtala, & Niinimäki 2016). The project is multidisciplinary by nature, aiming even for interdisciplinary collaboration and defined as a design-driven process. This chosen strategy means that creative and collaborative methods are used throughout the process. While traditionally, innovation processes are driven by technology initiatives, here the creative aspect of the design is given the role of forerunner within an interdisciplinary collaboration to enhance new perspectives in knowledge sharing. Design methods created the grounding and the “glue” for three different streams within the project: Design Research Stream, Science and Technology Stream, and Manufacturing Stream, in order to work towards the same objective

Figure 5. Eugenia Smirnova's tests on colour recycling from textile waste (photo by Eeva Suorlahti).

and achieve the best results. During the project, creative design methods for interdisciplinary material-based and collaborative research have been developed. A design-driven approach can challenge the traditional technology-driven innovation process by bringing in new, unexpected elements, combining different knowledge flows or challenging the traditional way of realising invention in the material sector (Niinimäki 2018a). A good example of this is fashion designer Eugenia Smirnova's MA thesis (Smirnova 2017), in which she collaborated with material researchers, worked in their lab to get to know the process and began to question, what might happen if colour was recycled and not only fiber. Based on this idea and colour tests she constructed a new concept of a colour library; how designers will work in the future, a future where all fibers are recycled, and colours are kept throughout different lifecycles, while closing the material loop (Smirnova 2017).

New technologies for using textile waste are being developed, creating new challenges to the original garment design while considering the end part of its lifecycle, e.g. the fiber content in the garment. The sorting of different textile waste materials is an important phase while recovering waste. Unfortunately, a lot of fashion items are made from blends, very often from 3–4 different fiber types, and this combination might prevent their recyclability. Also, the information about fiber content is not always correct, which also prevents garments from entering certain recycling processes. Recently, an automatic sorting system using robotics has been tested with textile fibers (e.g. in Trash2Cash project). New kinds of sorting plants for textile waste have also been established, with one new plant planned to be built in Southern Finland in the near future.

More creativity and collaboration are needed

Redesigning materials, systems, and products for circular use is a fundamental requirement of a circular economy and therefore represents a giant opportunity for companies, even in product categories that aren't normally considered innovative (Nguyen, Stuchtey & Zils 2014, 15).

“Design is a key to circular economy” says Ken Webster (2017, 66). He further quotes Nigel Cross, the leading researcher in design thinking, “scientific problem solving is done by analysis, while designers problem solve through synthesis” (ibid. 66) and he links this approach to a wider system perspective. While we need the system approach for CE, designers can help to navigate through “complex interactions, iterations (feedback) and uncertainty” highlights Webster (ibid.). Designers can in fact use their creative skills to enhance collaboration between different knowledge areas (Niinimäki 2018a), to build new networks and connections between different stakeholders and to push the boundaries between different disciplines (Niinimäki, Tanttu & Kohtala 2017). Moreover, the choices made during the initial design phase determinate if the product is possible to recycle and therefore is it suitable for several lifecycles. Moreover, the PSS; Product-Service-System requires a new approach to product design, while here the focus is on utilization and use, focusing on fulfilling users’ needs in more creative ways, not the product design or manufacturing alone.

But not only design creativity is needed to transform existing challenges to opportunities. We need more creative thinking in business, industry and technologies. We need to construct experimentation concerning how different business models could work with services, different profit-making logic, and with new practices at different levels (micro and macro, local and global). Businesses have to think how to best create stronger brand value in the context of sustainability, which could be used even in the second-hand market, how high-quality brand clothes could have another “business cycle” as second-hand clothes

(e.g. Filippa K, Emmy). Business has to think about how to create new profit-making possibilities from services (e.g. Vigga or Mud jeans and leasing cloths), from extended product lifetimes, or from reuse or recycled strategies in fashion. In this regard, a more experimental economy is needed, i.e., an economy which is based on circular experimentations and forerunner companies.

Also, new kinds of networks are needed. Networks which combine different stakeholders, different knowledge areas and which boldly begin to challenge the linear model and think things differently. There already exist good examples of what this kind of networking can best achieve. Furthermore, policy makers are needed for this work to solve the question of what would be the best way to invite (even force) companies, industry and consumers into this transformation process. As Sanders (2015) puts it, collaboration is the key for a successful outcome in complex problem settings. “Collective creativity refers to acts of creativity that are experienced jointly by two or more (and sometimes even crowds of) people” (ibid. 296). Complex sustainable issues like circular systems need to be approached through a collaborative, experimental and creative mindset to be able to find solutions together. “The only way we will be able to address the important challenges we face today is to do so collectively. Collective creativity can lead to relevant and sustainable innovation” (Sanders 2015, 298). In the best creativity can be used to challenge the whole industry, the way we design, manufacture, do business and consume fashion. We have to align creativity and innovative economy in the context of circularity. Here I want to quote Infinited fiber company and their statement of values which they think can help facilitate the BIG change.

Values:

Innovativeness: The more brains the more change

Openness: Together we will find affordable solutions

Solution oriented: We want to put all in

(<http://infinitedfiber.com/strategy-2/>)

Strategic design and innovation in a CE context

As Kretschmer (2014, 181) highlights in the context of sustainable development, design has to move from the “beautification and improvement of products” towards a wider perspective and system thinking, that is, strategic design. Systems approaches do not remain at the product design level only but widen the design aspects towards cultural aspects (cultural transformation process). Understanding sustainable innovation through this way extends the design process from products to “human needs, to ways of satisfying them, and, if appropriate, to transforming them into artefacts. Accordingly, sustainable innovation includes societal system innovation, usage innovation, organizational innovation etc.” (ibid. 182). Kretschmer further argues that product innovation alone might not be the best solution to a certain problem in the context of sustainable development. He further proposes that new knowledge is needed at the front-end stage of innovation to find the right focus for the innovation, which might not in fact be a new product.

In the linear economy, design has been used to keep the consumption rates high. This has to change in the CE context, and material throughput in the system needs to slow down. Even if the waste can be handled differently in the future, a CE approach cannot give permission to maintain unsustainable fashion consumption rates at the current level. Fashion consumption needs to transform. “The commonly accepted role of design as a cheap resource of ideas, as a profession of beautification, and as a powerful marketing ‘tool’ must therefore be questioned seriously and urgently” (Kretschmer 2014, 183). If the industry continues on the traditional design path, it will lose the potential of creative thinking to change its business assets towards a more sustainable future. More creative and strategic design is needed to build a sustainable product culture which takes into account, and more importantly leads towards, sustainable fashion consumption practices even in a CE context.

Design principles in CE

Good stuff is durable, made from locally sourced, sustainable materials, is repairable, fit for purpose and dismantle-able (thus easily up-cycled or recycled). It has a valued purpose (not just a fantasy-advertising-based, flash-fashionable appeal). Let's make stuff remarkable again. Meaningful. Special. (Fletcher 2017, 19)

This quote from Cat Fletcher (2017) highlights the key issues in design for circularity. We have to change our current and familiar design strategies while working in the context of a circular economy. We have to create new strategies for designing with quality and life cycles in mind. We have to be able to design for several life cycles and these different cycles need to be included with the design solution of the original product. We have to focus on creating something more meaningful and special for the end user. Something that they are ready to fall in love with, keep long, cherish and take care of (e.g. Niinimäki & Koskinen 2011; Niinimäki & Armstrong 2013). We should avoid designing disposable products, or alternatively we either have to find ways to effectively produce them from eco-materials or recycle them into new textile materials with low environmental impact. The best new design is included into the new business model which focuses on use and providing value through deep satisfaction in utilization, not only on easy profit via a single sale.

Based on the earlier discussion, the following design guidelines for a circular economy have been constructed in Table 1.

The list starts from the designer's daily practices and more traditional design tasks, such as dealing with style, quality, and the aesthetical aging of materials or styles. Then the list moves to include the users' world, how to trigger the user to extend the lifecycle of the garment, how to intensify the use or how to include the service aspect within the design and business concept. In this way the emphases upon the circular system is included. We need to use recycled materials more and also think about the product's recyclability. The work of designers moves towards the

Table 1. Design guidelines in a CE.

DESIGN	KEY STAKEHOLDER	IMPACT
Design for quality and long-term use	Business, Users	Extending the lifecycles, aesthetical aging, product satisfaction
Emotional Design	Users	Slowing consumption through deep product satisfaction and person-product attachment
Design for easy repair, reuse and redesign	Business, Users	New business models (e.g. services)
Design within new business models (e.g. swapping, second-hand business, PSS, renting, leasing)	Business, Users	Extending or intensifying the use
Design from recycled materials	Industry, Business	Creating demand for recycled materials
Avoid harmful, toxic chemicals and substances	Industry	Supporting CE system
Design for recycling (easy disassembly or made from mono-materials, recycling all materials and chemicals in a closed loop manner)	Industry, Policy	Creating CE system
Design for transformation	All	New paradigm

future and because of that towards more intentional design. “The intentional design space points toward the future. Design embodiments that emerge from an exploration of intentional design space include organizational transformation, behaviour change, and/or social transformation” (Sanders 2015, 298). This aspect creates new challenges for design skills, because we have to design for a larger scale or with a view to a longer future, to construct the transformation towards a circular system as a

whole. Here more strategic thinking is needed and also large-scale collaboration needs to be achieved. In the CE context, including systems thinking and new collaborations, changes fashion design and the role of the designer becomes a knowledge-intensive profession, more so than if it merely emphasized aesthetic or functional outcomes.

Impact

One focus in the circular economy is to support activities in more local and regional contexts than in the linear economy. Waste is best handled locally rather than by being transported long distances to the other side of the globe. Reuse, updating, and modification can be achieved more flexibly within close distance, and in this way such activities support the local economy. The new sharing economy (e.g. swapping) needs local actors and local communities to create a viable new economy, even a block economy.

Investing in and creating local actions intensifies the use of labour. Many of the activities within the circular economy are labour-intensive and can create new boosts in the micro- and also macro-levels of the economy (Stahel 2017). “By rethinking the way we produce, work and buy, we can generate new opportunities and create new jobs”, has been stated in the EU’s Circular Economy Package (EU 2.12.2015), giving positive futures a path to follow. WRAP predicts that change towards

Table 2. The effect of extending the use time of garments (WRAP 2012, 23).

EXTENDING THE USE WITH	CARBON SAVING	WATER SAVING	WASTE SAVING
10% = 3 months	8%	10%	9%
33% = 9 months	27%	33%	22%

circularity could generate up to 3 million new jobs in the EU by 2030 (WRAP 2015).

Circular thinking (extending and intensifying use, reuse, redesign, recovering waste) uses fewer resources, and preserves the water and environment, ending up in low-carbon use, less use of energy and fewer virgin materials, making circularity, therefore, more ecological than industrial processes in the linear model (Stahel 2017). WRAP (2012) has calculated the effect of extending the use time of garments. According to WRAP the average lifetime of a garment in the UK is 2,2 years. From the figures in Table 2, we can see that even a slight change in consumer behaviour can have a big effect. For example, 9% savings in waste means 150 000 tons of waste in the UK alone.

Conclusions

Circular economy is an emerging phenomenon which will totally change the fashion system. Companies and designers at the forefront will be leading the transformation of the fashion industry. On the other hand, individual designers, small companies and even grass root initiatives can show the alternative ways towards more sustainable futures. There already exist examples of how to design, manufacture or do business in the context of CE. Policy and legislation are tightening, at least on the European level, and companies who are prepared for this can lead the way towards the CE business and CE society at large.

When constructing a new understanding of the circular economy, all levels need to take into account; consumption, design, business, industry and waste management. This needs a systemic perspective and tight collaboration between different stakeholders. On the other hand, new understanding and new networks open different business and design opportunities. It can be summed-up that the transformation towards circularity needs creativity, new way of thinking and acting, new networks, large collaboration and brave experimentation.

Companies mentioned in the text

<http://filippakcircle.com/>
<https://global.makersite.net/>
<http://infinitedfiber.com/>
<https://mudjeans.eu/>
<https://store.emmy.fi/>
<https://vaatepuu.wordpress.com/>
<https://vigga.us/in-english>
https://www.annaruohonen.com/fi_FI/
<http://www.lena-library.com/>
<http://www.made-by.org/>
<https://www.nudiejeans.com/>
<http://www.patagonia.com/ironclad-guarantee.html#searchterm=guarantee>
<http://www.purewaste.org/>
<http://www.reblend.fi>
<https://zadaa.co/>

Some interesting information on the web

WRAP Love your clothes -campaign
<https://www.loveyourclothes.org.uk/>
Circular Fashion
<https://circular.fashion/>
Circular Fashion Network
<https://circularfashion.com/>
Cradle to Cradle products
<https://www.c2ccertified.org/>
Fashion positive materials collection
<https://www.c2ccertified.org/fashionpositivematerials/>
Close the loop, a guide towards circular fashion
<https://www.close-the-loop.be/en>
EMF Ellen MacArthur Foundation, *A new textiles economy: Redesigning fashion's future*, https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report.pdf

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Sustainable Fashion Consumption

02

The Clothing Style Confidence Mindset in a Circular Economy

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Personal style has been implicated recently in the potential product longevity in clothing, underpinned by a mindset characterized by creativity, authenticity, and mindfulness, though little has been articulated as to what “style” necessarily means in real practice and how exactly this attribute influences sustainable consumption behaviors. The purpose of this paper is to define clothing style confidence and explore the impact of this attribute on clothing consumption habits, from purchase to disposal behaviors. Individual interviews were conducted with 23 women and men who self-identified as confident in their personal style. This study resulted in a definition of clothing style confidence and an illustration of its influences on consumption behaviors that may foster product longevity, playing an important role in a circular economy.

Keywords: Style, clothing style, sustainable consumption, purchase behavior, disposal behavior



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Introduction

Clothing is a prominent tool used to create one's expressed identity or personal style, defined by Kaiser (1997) as a distinct method of expression. This symbolic production of self is a reality in every individual's life, though research has shown that some individuals who lack a sense of completeness with respect to self-definition are more likely to use cultural symbols like clothing in pursuit of completeness (ibid.). Similarly, a research study discussed in Fletcher and Grose (2012) found that consumers who lack the confidence to experiment with existing garments frequently making new purchases to "reinvent" their expressed selves and evidence the highest material throughput and environmental impact. More recently, a variety of scholars have begun to correlate concepts related to style with sustainable consumption, providing evidence that those who have clarity about their personal style more frequently engage in practices supportive of sustainable development, such as reduced consumption, repair and maintenance, repurposing or redesigning, or other creative habits (Bly et al. 2015; Fletcher & Grose 2012; Ruppert-Stroescu et al. 2015). These practices support the product longevity of clothing, which is the cornerstone of sustainable clothing consumption (Cooper 2010). Niinimäki (2017) argues that consumers are a key stakeholder in this longevity by way of their habits and actions. Specifically, current sustainable consumption scholars suggest a type of style that is characterized by personal creativity, heightened self-awareness, and mindfulness (Bly et al. 2015; Fletcher 2016; Ruppert-Stroescu et al. 2015; Watson & Yan 2013). Therefore, this mindset has an important role to play in the implementation of the circular economy.

Bly (2013) recently argued that sustainability facilitates style, an antithesis to mainstream fashion and followership. In this light, freedom from fashion provides a more sustainable way to consume that is punctuated by self-awareness and creativity; free from fashion dictate, one may explore their creative expression without the continual acquisition of new things. They may also generate meaning with clothing more suited to one's personal values. Perhaps, those who are confident in the

symbolic production process of dress do so in a more reflective and consistent way, resulting in less material throughput and environmental impact. The emerging dialogue surrounding style and its potential role in sustainable consumption deserves much more exploration in regards to what role fashion (e.g., constant change, trendiness) plays in the development of this style as well as the degree to which one's style must truly be separated from the fashion system to meet sustainability aims.

The purpose of this project was to explore a comprehensive definition of clothing style confidence (CSC), a potential attribute supporting sustainable consumption, and explore how this attribute influences clothing consumption behaviors, including purchase, use and maintenance, and disposal behaviors. Individual interviews were conducted with men and women who self-identified as confident in their personal style, which provided a window to illuminate CSC's role as an important and emerging sustainability concept. Following, a discussion of style, creativity, and freedom form the building blocks that supported this investigation. Then, a discussion of methods is followed by an outline of research findings and concluded with a brief discussion of implications.

Background

This emerging focus on personal style and sustainability has evolved quite naturally during an age of abundance in the marketplace; the access to appearance modifying tools like clothing has significantly expanded. Facilitated by an abundance of props, experimentation with style also occurs to resolve cultural ambiguities about aspects of life such as gender or social class (Kaiser et al. 1991). This prompts a transitional space in time where style is permitted to become much more heterogeneous (Kaiser et al. 1991; 1995). Could this more heterogeneous landscape support sustainability? We must first situate style in this landscape, then explore how aspects articulated by recent scholars, like creativity and freedom, may help define a type of style confidence that encourages sustainable consumption.

Style

As we begin to shape a conceptualization of clothing style confidence (CSC), it is important to first clarify what style means. Kaiser (1997) defines personal style as a distinctive method of expression that is developed through one's creativity and experimentation with "tools and props" (ibid. 503). Style is different from fashion. Style evolves slowly and reflects an individual's identity, inner self, and way of life. Fashion, on the contrary, is temporary and ever-changing trend, and reflects more outer self (Gwozdz et al. 2017). Gadel (1985) characterizes style-oriented consumers as prioritizing dressing well and being interested in the cut or style of garments (e.g., "fashionable" or "interesting"), the appearance of garment quality, and garment performance. Kaiser (1997) contrasts style-oriented consumers with pragmatic consumers who are focused on easy care and low-cost maintenance of clothing. Style-oriented consumers can also be fashion-oriented, which is an interest in staying up-to-date with trends; though most style-oriented individuals prefer clothing that will not go out of style quickly. To be sure, style and fashion orientations are not positioned at two ends of a continuum; rather both are aspects of the personal style experience (ibid.). Notably, Gadel (1985) articulates that just because someone is style-oriented does not necessarily mean they are confident in choosing styles and color or necessarily have a flair for dressing well.

There are recent studies that further aid in delineating style's potential role in sustainable consumption. Zarley, Watson and Yan (2013) conducted an exploratory study of the decision processes of fast versus slow fashion consumers. The slow fashion consumer is preoccupied with quality over quantity, seasonless style, simplicity in form, garment details, and achieving versatility with fewer clothing items to maintain longer wear. Study findings affirm that these consumers have a non-trendy self-image; therefore, personal style is a greater factor in clothing choice than fashion followership. Similarly, Cho et al. (2015) recently proposed a concept called style consumption as a "distinctive mode of tailoring of a given time which evolves slowly, thus, having the quality of being eternal," arguing that style consumption begets longer wear

and increase garment retention over time by acquiring goods that align with one's personal style (Cho et al. 2015, 2). These researchers found that style consumption positively influenced both environmental apparel purchasing and sustainable apparel divestment practices (ibid.).

Fletcher and Tham (2004) categorized clothing consumers by material throughput and environmental impact based on levels of fashion interest and motivations, proposing that there are two types of consumers who evidence a lower environmental impact: 1) those who have less interest in fashion and consume for quality and timelessness, and 2) those who have more interest in fashion and consume for creative ends (discussed more in Fletcher & Grose 2012). Neither is necessarily a fashion follower. Instead, these consumers develop their own style and consume strategically, overall consuming and disposing of less than the slave to fashion. This can be contrasted with fashion leaders who prefer a hedonic shopping experience and have a tendency to need emotional and experiential satisfaction during shopping (Kang & Park-Poaps 2010; Kim & Hong 2011). Clothing is highly varied in its uses and the symbolic reasons for its use, and environmental strategies to increase sustainability must be tailored to these ends, which can include a respect for fashion (Fletcher & Grose 2012). On the other hand, Fletcher and Tham (2004) also point to a lack of confidence as problematic in the case of the slave to fashion, who frequently purchases superfluously to express disparate identities. We now turn to discuss more specifically the role of creativity and freedom as potential aspects of a type of style confidence that supports sustainability aims.

Creativity

Innovative and creative people are more prone to play with aesthetics (Baudrillard 1994), the goal of which is often to seek distinction from others (Baudrillard 1994; Tian et al. 2001). Meeting the need for creativity is a dominant motivation for clothing consumption (Fletcher 2012). Individuals who use clothing as a symbol in expression of creativity are motivated by fashion change (ibid.), which can increase the

purchases of products that are used for shorter time periods (Ritch & Schröder 2012). However, creativity was recently identified as being linked to problem solving in cases of reduced consumption by engaging in practices that support sustainability, such as repurposing, redesigning, or other creative habits (Ruppert-Stroescu et al. 2015).

Ruppert-Stroescu et al. (2015) discovered a variety of creative contributions that aid in problem solving when the acquisition of new clothing is dramatically reduced. The study found that when research participants refrained from new clothing acquisition for a specific time period, attitudes and behavior toward clothing began to change, prompting creative expressions. Research participants spent more time assessing their wardrobe and put more effort into creating outfits that were not prescribed by a retailer. They discovered a new perception of their wardrobe, seeing items in their wardrobe in ways they had not noticed before. Some began altering garments by modifying, mending, or redesigning. Others borrowed goods from others to stimulate creativity in the wardrobe. Most importantly, participants experimented with new styles of dress that they wanted to try, and in turn, this intensified their sense of personal style (*ibid.*).

Similarly, Lapolla et al. (2015) argued that though clothing repair is not as common in the household today and many lack the skills to repair, one way to reduce textile waste is to encourage clothing reuse and repair through creativity. Types of creative activities found to support garment longevity via reuse and repair were closet organizing/re-organizing and donating clothing, modifying apparel to make it more personal, and achieving better fit and increased uniqueness. Research participants in this study expressed a desired for more guidance and expertise to improve garment longevity by acquiring the skills to modify garments, mix and match wardrobe items, and create new types of products from old clothing. Learning new skills and having guidance was perceived as important to increasing creativity with clothing reuse and repair. These studies highlight the importance of style and creativity in sustainable clothing consumption behaviors.

Freedom

In the aforementioned study by Ruppert-Stroescu et al. (2015), some research participants who abstained from new clothing acquisition for a period of time employed their creativity with their existing wardrobe to continue to look fashionable and compliant with current fashion trends while others rejected subscription to fashion trends altogether and redirected their attention to other items in their environment. Indeed, the degree to which one's style must truly be separated from fashion precept has implications for consumption behavior that beg empirical exploration. The current literature seems to suggest that this age of abundance and heterogeneity of style could prompt the entrance of a type of personal style that is not necessarily isolated from but is also not entirely beholden to the fashion system. A space may now exist where one can explore creative expression; generating meaning that is more tightly aligned to one's goals, values and personal narratives (Bly et al. 2015; Fletcher 2016).

One might assume that clothing style confidence (CSC) implies a certain disregard for the fashion system. Yet, this perspective may ignore a possible mindful navigation of the fashion system where one could engage in fashion without the excessive material throughput, as suggested by Cho et al. (2015). The first scholars to discuss such freedom were Lowe and Anspach (1973), who describe a consumer mindset called freedom in dress; considered a separate dimension of appearance management that is characterized by three dimensions that include: 1) an individually or subjectively defined state of mind, 2) "dressing freely," including purposeful planning, execution and pleasure in the results, and 3) a process conducted on the basis of restrictions and satisfactions related to clothing: economic (budget), social (peer group) or perceptual (aesthetics). In this light, a consumer believes they have control over what they wear, are capable of choosing among available clothing alternatives, and are satisfied with the choices they make.

Concerning sustainable consumption, interesting aspects of this state of mind include the embodied mindfulness and autonomy in carefully planning, executing and enjoying clothing choices that align with

one's sensibilities as well as the inherent satisfaction gained by navigating certain constraints, such as income (Lowe & Anspach 1973). For instance, individuals who are "free" may be able to overcome economic restrictions by using originality and creativity in appearance management. Further, social-psychological considerations may also play an important role in overcoming economic constraints, such as praise from others or an absence of criticism; the degree of favorable acceptance determines a feeling of being free. This state of mind must be defined by the individual and cannot be objectively defined by others in terms of color, style, etc. An important and related aspect of this mindset is an attribute called aesthetic perceptual ability, which the authors define as the ability to coordinate interesting appearance contexts (*ibid.*). In sum, the person who is the most capable of deciding between equally attractive alternatives and is most satisfied with the clothing chosen experiences the greatest freedom (Lowe & Anspach 1978).

The concept of freedom in dress has primarily been explored to understand purchase decisions rather than the entire consumption experience, including style. Nevertheless, the notion of freedom merits consideration in the context of sustainable consumption. Kaiser (1997) has discussed how emerging subcultures can influence a disregard of the fashion system. The development of personal style becomes a form of mutiny, most frequently conducted by innovative and creative individuals who play with aesthetics in search of distinction (Baudrillard 1981). Subsequently, heterogeneity in style proliferates. On the other hand, Cho et al. (2015) more recently describes a type of style consumption that evidences an interest in fashion without a wholesale subscription to it. Thus, more recent literature seems to depict a mindset where one may honor their own personal style by making good choices. The inadequate empirical exploration of this type of consumption is chiefly what propels this study.

Methods

To begin developing a comprehensive definition of clothing style confidence (CSC), the authors reviewed literature relevant to personal style, such as appearance management, symbolic interactionism, and sustainable consumption. This literature was utilized to develop an interview protocol, developing interview questions related to appearance evaluation, orientation, and investment, style orientation and fashion consciousness as well as questions about purchasing, use and disposal practices. A pilot exercise was conducted with five women and one man who all self-identified as style confident. On the initial protocol, a series of questions prompted the participant to discuss how they defined their personal style, which did not yield useful feedback during the interviews. These were replaced with more specific questions about appearance management behaviors. Additional questions regarding purchasing and disposal behavior were also added to permit a better understanding of how this type of confidence influenced behaviors relevant to sustainability.

The authors then conducted 23 individual interviews with men and women who self-identified as style confident. To begin recruiting participants, a short list of ten personal contacts who appeared to embody style confidence were identified. These participants were contacted via email and invited to participate if they identified as “*confident about the individual way they express themselves with clothing and accessories*.” Most interviews were conducted in 30–45 minutes via a web application, which allowed the authors to conduct the interview in an online chat and receive the transcript of the interview. This aided in prompt review and analysis of the data. Four participants requested an in-person interview, and these were audio recorded. After these interviews, one of the authors reviewed the audio recording and made extensive notes. These notes along with the other transcripts were loaded into Nvivo software for qualitative analysis. All transcripts were reviewed by both authors and discussed to identify initial themes. Then, the primary investigator coded the 23 transcripts.

Discussion of findings

The following discussion is organized around the study's two primary objectives: 1) to explore a comprehensive definition of clothing style confidence (CSC), and 2) explore how this attribute influences clothing consumption practices, including purchase, use and maintenance, and disposal behavior.

Defining clothing style confidence (CSC)

Five attributes characterize the life of the style confident: style longevity, aesthetic perceptual ability, creativity, appearance importance, and authenticity (see Table 1). **Style longevity** refers to the preference for purchasing clothing with a long-term view, which includes avoidance of quickly passing fashion trends. Participants articulate a style- rather than fashion-orientation when it comes to clothing purchasing and dress. Some participants articulate that they are aware of and are even inspired by fashion trends but do not blindly follow. Rather, they select from the new trends carefully to align with their personal style. **Aesthetic perceptual ability** refers to the ability to put clothing together in an aesthetically pleasing way, including perceived knowledge about what flatters the body. Participants articulate that they are knowledgeable about and may have even developed rules for how clothing items coordinate, including clothing selection and coordination to flatter the body and personal style. **Creativity** refers to an individual's interest in developing one's own style by mixing and matching clothing to experiment with new and different looks. Participants articulate that they enjoy the creative process of putting outfits together, which may include experimenting with their personal style with a sense of adventure. Some participants also discussed mixing and matching clothing in new ways to breathe new life into older garments. **Appearance importance** refers to the degree to which one considers his/her appearance to be important. Participants articulate that their appearance is important to them and they are satisfied with their

Table 1. Attributes that Characterize the Style Confident.

CHARACTERISTIC	DEFINITION	PARTICIPANT COMMENTS
STYLE LONGEVITY	The preference to purchase clothing that can be utilized for a long time; some preference for timelessness.	"I don't buy too trendy items since it will be out of date very soon." "I've always been interested in fashion and current trends but more as a way to supplement my own style rather than a way to copy others."
AESTHETIC PERCEPTUAL ABILITY	Perceived knowledge about what clothing looks good on the self, including what flatters the body and the ability to put clothing together in an aesthetically appealing way.	"I think that I know what looks good on me." "If I am trying to accentuate a certain part of my body I will find what looks the best."
CREATIVITY	One's interest in developing one's own style by mixing and matching clothing to experiment with new and different looks.	"I enjoy playing with my style and recreating my look on a daily basis." "I like layers, and sometime I try to wear my old clothing in different way. For example, if I don't like my old shirt, I will wear it with a jacket. You know there are hundreds of ways to wear one piece of clothing."
APPEARANCE IMPORTANCE	The degree to which one considers his/her appearance to be important.	"I feel that my appearance is a way that I represent myself; self image is important to me." "Personal appearance is one of the most important things in my life. It makes me feel confident and comfortable in front of other people."
AUTHENTICITY	How well one's clothing style reflects the "real me".	"I dress the way I do to please myself." "I've become more comfortable in my skin and wearing something that is not in the 'norm' does not scare me off. I know it works for me."

level of attractiveness. Some participants discuss that this may include an extra effort in planning what they will wear. **Authenticity** refers to how well one's clothing style reflects the "real me." Participants articulate that dressing according to their personal style is a way of expressing who they are. Being genuine in this context is important to them. This knowledge of what aligns with their personality and what does not has developed over time.

Clothing style confidence and consumption behaviors

Research participants discussed that their consumption behaviors were certainly shaped by their surroundings, living location, working environment, social group, etc., including fashion marketing and trends. However, participants use a clear sense of self to negotiate these influences as they formulate a response. One participant remarked, "Starting a job in the corporate world has influenced my style ... I realized that I have been dressing just like everyone else at my job ..." Another participant mentioned, "I started working through some personal stuff that was hindering my self-confidence and through my fashion choices, I was able to achieve a sufficient and independent lifestyle." These participants do not simply follow trends or imitate what other people are wearing; rather they create their own look that reflects their personal style and exemplifies who they are. The following discussion highlights the various ways this confident sense of one's style may influence consumption behavior, including purchase, use and maintenance, and disposal (see Table 2).

One outcome of having confidence in personal style is more awareness of their needs before they go shopping for clothing, resulting in **strategic purchasing**. Participants explained that they often know what specific item they are looking for and focus solely on that when shopping. As some participants mentioned, "My shopping is more directed ..." and, "... I always know what is right." Many other comments indicated that participants often have their existing wardrobe in

mind while shopping for new clothing; therefore, they are able to create more looks by mixing and matching their new and existing clothing items. For instance, a participant stated, “When I purchase my clothing, I always think about if this piece matches some of my other pieces.” In addition, avoiding trendy styles is another aspect of this strategic focus. Participants note that instead of following trends blindly, they choose what they know looks good on them and will last a long time. One participant explained, “... All of my clothing and accessories are almost all trendless: safe color, safe prints, and safe silhouette” while another participant noted her interest in current fashion though she considered longevity in other aspects, “I would think about how often I will wear the clothing before I decide to buy.” Participants also discussed impulse shopping, which was not necessarily uncommon but similarly precise. A number of participants said they would buy impulsively, yet very few said they regretted these impulse purchases later -- they know themselves and make good decisions, even on impulse. For example, a participant stated, “I rarely experience regret when buying clothes;” and another said, “It is rare for me to feel regret because I really think about my purchases, especially if they are expensive ones.” Notably, being creative often enables this type of consumer to find different ways to wear their purchases.

In regard to the use and maintenance of existing wardrobes, many of the comments discussed by participants pertained to **wardrobe preservation**. Many stated that they devoted extra effort to take good care of their clothing to increase its lifespan and keep it in a good shape. For example, one participant mentioned, “I promptly repair clothes that need repair and I wash them gently and regularly and I follow the instructions on the tag. I store them with wooden hangers and I fold them carefully ...” Hand-washing, reducing the frequency of laundering, prompt repair, and avoiding the use of a dryer were the most common strategies that participants applied in the maintenance of their clothing. As one participant said, “I only wash my clothing in cold water and I don’t dry anything. That way, none of my clothing has the chance to fade or shrink.”

Table 2. Clothing Style Confidence and Consumption Behaviors.

PHASE	THEME & DEFINITION	PARTICIPANT COMMENTS
PURCHASE	Strategic purchasing Participants know specific items they are looking for and focus on that during shopping, including seeking items that work with existing wardrobe and selecting items the permit longevity and are congruent with personal style.	"When I shop, I will look for things that will go well with the things I already have." "I rarely buy something that I don't wear."
	Wardrobe preservation The care and maintenance of clothing, including rotating wear, repair, laundering, and storage.	"I store them with wooden hangers; and I folder them carefully." "I don't wash some of my more expensive pieces after I wear them because of how it ages the fabric."
USE AND MAINTENANCE	Wardrobe engagement Knowing what is in one's closet, organization for the purpose of developing outfit ideas and identifying items to keep /discard.	"I like to be able to see everything. I have several scarf hangers and all my jewelry is out on display. My closet is very organized. This also helps me to be creative because I can see all my options." "I try to go through my closet every few months. If there's something that I can't remember the last time I wore it, I set it aside for donation. This keeps my wardrobe much smaller."
	Infrequent clothing disposal Clothing disposition is rare but a necessary part of maintaining active engagement in the wardrobe.	"I rarely discard, if I am tired of it, usually if I wait a little bit, I'll find another way to wear it." "It is hard for me to get rid of something because even if it is ridiculous or I'm tired of it, usually if I wait a little bit I'll find another way to wear it."
DISPOSAL	Reuse and repurpose Disposal is often avoided via ideas about how to utilize existing clothing in new ways.	"If I have a jacket that doesn't fit my shoulders anymore, I'll cut off the sleeves and make a vest." "I repurpose a lot. Or just keep the garment to use the fabric for something else. I never throw anything away. If I can't repurpose it, then it gets donated."

Further, participants also discussed active **wardrobe engagement**. Regularly sorting through their wardrobes often enables them to have an idea in their minds of what they can use to create different looks each day. For example, one participant stated, "... I go through my closet about every 3–6 months ... this keeps me from holding on to things I don't need and it keeps my entire closet in front of my eyes, so I don't go out and buy something too similar to what I already own." One of the characteristics of style confidence is being creative through more frequent wardrobe engagement, which enables them to have a better idea of how to mix and match their existing wardrobe.

Disposal behaviors are also impacted by the confidence in personal style. Participants noted they engaged in **infrequent clothing disposal**. Participants explained that though clothing disposition was part of maintaining active engagement in the wardrobe, being creative enables them to mix and match their existing clothing to create new looks and experience longevity in the wardrobe. Further, instead of throwing away their used clothing, many participants noted they would **reuse or repurpose** items: "I repurpose a lot. Or just keep the garment to use the fabric for something else. I never throw anything away." Another participant remarked, "I never throw away my necklaces if they break. I usually keep the charms and buy new chains or change the chains out depending on what charm I'd like to wear. I also sew my clothing when it tears." Participants discussed that they frequently have ideas about how to use their existing clothing in new ways.

Implications and conclusions

The current dialogue surrounding style and its potential role in sustainable consumption deserves much more exploration, particularly to define this type of style and how this attribute may influence clothing consumption behaviors: purchase, use and maintenance, and disposal. This study has provided a window to illuminate clothing style confidence (CSC) as an important and emerging sustainability concept. To

be sure, CSC is situated in a transitional space in the present day where appearance-modifying tools like clothing are far more abundant, and consequently, personal style has become more heterogeneous (Kaiser et al. 1991; 1995).

The study has advanced a formal definition of clothing style confident (CSC) *as confidence about the individual way one expresses themselves with clothing and accessories, which includes a preference for style longevity, an aesthetic perceptual ability, engagement in creativity, a priority given to appearance, and an emphasis on personal authenticity*. CSC is distinct from style-oriented consumers, who prioritize their interest in clothing style and quality, because those who exhibit CSC are confident in choosing styles and color as well as generally prioritize dressing well while style-oriented consumers may not (Gadel 1985). CSC consumers are also distinct from pragmatic individuals who are focused on easy care and low-cost maintenance of clothing (Kaiser 1997). The style confident are not necessarily fashion-oriented, which is an interest in staying up-to-date with trends (ibid.), but instead participate in the fashion system much more strategically and mindfully, preferring longevity in the wardrobe by avoiding quickly fading trends and carefully selecting only current fashion that supports their style. Though CSC shares some attributes with the slow fashion consumer (Watson & Yan 2013) as well as the concept of style consumption (Cho et al. 2015), especially in regards to seeking versatility with fewer items or avoiding quickly-passing fashion trends in an effort to achieve longer wear in the wardrobe. But, the CSC consumer does not appear to prioritize specific garment styling, like seasonless or simplistic or classic. There was, indeed, a diverse array of expressive styles communicated among the research participants. Notably, CSC consumers do not exist in isolation of the fashion system; rather, they participate in current fashion by strategically selecting only what they know tightly aligns with their own style agenda (Bly et al. 2015; Fletcher 2016). Fletcher and Tham (2004) found consumers who had a lower material throughput and environmental impact were either interested in timelessness or consuming for creative ends. The current research project seems to support these aspects of style experience.

Study findings support that this confidence in personal style appears to play a role in regards to some consumer behaviors supportive of sustainability aims, including strategic purchasing, wardrobe preservation, wardrobe engagement, infrequent disposal, and a penchant for reuse or redesign. This confirms some findings by Cho et al. (2015) who found the aforementioned style consumption associated with environmentally-oriented purchasing and divestment practices.

If style confidence strengthens the potential for sustainable clothing consumption, the implications are assuredly of the educational variety. The marketplace has seen a proliferation of style consulting services as well as style-related retail offerings, such as Stitch Fix or Trunk Club, that aid the consumer in better understanding their personal style and aligning their purchases to that style. On the surface, these emerging industry models appear to aid consumers in clarifying their personal style, which is a part of CSC. Consumers with a high level of confidence in personal style have a greater sense of who they are and how to express the self. They do not simply follow the latest trends or copy what other people are wearing while shopping. Instead, they create their own look that reflects their personal style and exemplifies who they are. They know what will reflect the “real” self and dress in a way that is satisfying to them.

Yet, the skill set described by these research participants goes much deeper than clarity in style alone. Specifically, creativity (Ruppert-Stroescu et al. 2015) and aesthetic perceptual ability (Lowe & Anspach 1978) enable consumers with CSC to know what clothing looks good, including what flatters the body and the ability to put clothing together in an aesthetically appealing way. They utilize this creativity and aesthetic sense to mix and match everyday looks, maintaining active use and organization of the wardrobe. These consumers consequently dispose of clothing less frequently because their creativity enables them to create different looks from their older clothing items or to know how to reuse or redesign the item. Some of these characteristics align with other studies by Ruppert-Stroescu et al. (2015) and Lapolla et al. (2015) that associate creativity with style exploration and longer

wear. Finally, CSC consumers also have knowledge about the impacts of laundering, taking care to preserve their wardrobes through fewer washings, careful storage, and occasional repair. These competences in creativity, aesthetics and garment care and maintenance describe key areas of consumer education that may strengthen the sustainable clothing consumption imperative. This education will be central to transform consumer mindsets and better support clothing product longevity, and therefore, a circular economy. Future research is now needed to better understand how to shape specific interventions to increase CSC among those who evidence higher material throughput and environmental impact in the wardrobe.

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Sustainable Fashion Consumption

03

Collaborative Consumption and the Fashion Industry

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This chapter focuses on collaborative consumption, a ‘newly’ emerging phenomenon within the UK fashion industry. Although not new per se the topic area remains under researched and lacks clear-cut definitions. This chapter provides an introduction to collaborative consumption by exploring its origins, definitions, key characteristics, and terminologies used, before moving onto exploring collaborative consumption examples. Future areas of research are highlighted to further examine a field of increased interest within the fashion industry.

Keywords: Collaborative consumption, UK fashion industry, swapping, emerging phenomenon, sharing

Emergence and definition of collaborative consumption

The 21st century has seen dramatic changes in the fashion industry's landscape; not only are consumers more conscious of the impact that their clothing has on the environment (e.g. Eckhardt et al. 2010; Hamari et al. 2016), but also media outlets globally report on a relatively new trend in the fashion industry: *collaborative consumption* (e.g. Purvis & Evrenos 2014; Hoh 2017). Although *collaborative consumption* is not new per se, it thus far lacks a clear-cut definition and can best be described as an intuitively understood, yet fuzzy concept (Markusen 1999; Codagnone & Martens 2016). This chapter explores the current debate in the literature on *collaborative consumption* by investigating its origins and providing an overview of key definitions, before moving on to discussing its terminologies and examining challenges associated with it, by further providing examples.

In its simplest form *collaborative consumption* can be described as a transactional exchange between parties, and thus is “as old as human-kind” (Belk 2014, 1595). Sheth et al. (2011) emphasise that consumers participating in these exchanges seek to ‘trade up’; they aspire to gain products better than those they have traded in, as individuals associate their belongings with self-expression and self-worth (Belk 1988). As such, trading in their own clothes for ‘better’ ones may enable individuals to also move up the ‘social ladder’, as the items they have gained may be associated with a higher social class and/or the individual’s aspirational group. In its early stages these exchanges have predominantly happened in close-knit circles, among friends and family, which is often referred to as sharing-in (Ingold 1986; Belk 2010). Today, exchanges and sharing transactions are increasingly common among strangers and have been described as sharing-out activities (Ingold 1986; Belk 2010). The latter is accelerated with the emergences of new technologies and Web 2.0, as it has facilitated the creation of sharing platforms that can be used and accessed on a global scale. The most prominent sharing platforms can be found within the tourism industry (e.g. CouchSurfing,

Airbnb, SpareRoom) or in the transportation industry (e.g. Uber, Didi, CarShare), yet the fashion landscape has also seen some success stories in recent years, such as Rent the Runway, Lena the Fashion Library, and Chic by Choice (Pike, 2016). However, before engaging further with what challenges and opportunities are arising from these *collaborative consumption* business models, it is vital to define the term.

Felson and Spaeth (1978, 614) define the term *collaborative consumption* as “those events in which one or more persons consume economic goods or services in the process of engaging in joint activities with one or more others”. Whilst instructive, this definition has been criticised for being too broad and too inclusive (e.g. Belk 2014; Codagnone & Martens 2016; Iran & Schrader 2017), as any social situation in which individuals come together and ‘share’ something, whether purposefully (e.g. arranged) or accidentally, could be described as consuming something collaboratively. As such, this type of consumption could be more accurately described as ‘coordinated’, whereby individuals happen to be at the same place at the same time and consuming as a collective, yet the actual act of consumption is based on a marketplace exchange. Thus, Belk (2014) insists that Felson and Spaeth’s (1978) definition lacks a focus on acquisition and distribution of the actual resources. Botsman and Rogers (2010, xv) narrow down the meaning of the concept by providing a more focused definition, which sees *collaborative consumption* to include “transactional sharing, bartering, lending, trading, renting, gifting, and swapping”. Yet, a question that arises here is whether gift giving, sharing, and actual market transactions can and should be combined, as each have their own characteristics (Belk 2014)? To reiterate this further, gifting to someone means an item changes ownership from one party to the next, yet this may not necessarily imply that multiple people collaboratively consume this gift. Further, the motivations underpinning gift giving can fundamentally be different to those of collaborative consumption (Hollenbeck et al. 2006; Belk 2014; Corciovani & Dalli 2014).

Belk (2014) indicates that the definition of *collaborative consumption* needs to be inclusive, yet narrow at the same time. For him *collaborative*

consumption is defined as “people coordinating the acquisition and distribution of a resource for a fee or other compensation” (ibid. 1597). Although he recognises that acquisition and distribution of a resource takes place, through fee payment or other compensations, Belk (2014) broadens the definition to include transactions that entail a non-monetary exchange, such as bartering, trading, and swapping. This chapter follows Belk’s (2014) definition when discussing examples of *collaborative consumption* within the UK fashion industry.

Characteristics and terminology of collaborative consumption

The emergence of Web 2.0 and the creation of peer-to-peer platforms have enabled *collaborative consumption* to flourish, whereby individuals can make use of their idle capacities by simply exchanging them or renting them out, and thus, extending, in this case, the garment’s useful life and average time of wear (Kaplan & Haenlein 2010; Hamari et al. 2015). An example of this is Facebook Marketplace, which has boomed in popularity since its inception in 2016, whereby consumers can sell, giveaway or exchange any items, including clothes, shoes or accessories, to people in their local area. This has various implications for the industry in that consumers now no longer need to actually purchase garments and accessories, but can instead rent, swap, or exchange these in any other way (Bardhi & Eckhardt 2012; Benoit et al. 2017). It may thus not be surprising that *collaborative consumption* and its associated business models have previously been described as disruptive, as they are breaking the rules and norms of existing business practices. Although often said to be inferior to established business models, disruptive innovations provide alternative benefits that may attract consumers (Christensen & Raynor 2003; Markides 2006). For example, swap shops allow individuals to exchange their garments without having to make a monetary transaction, enabling consumers to change and revamp their wardrobe, whilst simultaneously discarding their unwanted items. Although the

economic aspect (Akbar et al. 2016; Park & Armstrong 2017) is seen as a draw for individuals into engaging with *collaborative consumption*, it is not always guaranteed that individuals will receive high quality items and/or have a consistent experience when embracing these disruptive business models (Richard & Cleveland 2016). Whilst the focus of this chapter is not on investigating the impact of disruptive innovations on the fashion industry – as this would exceed the scope of this chapter – it is vital to understand that these models can have both positive and negative impacts on the economy at large (Christensen & Raynor 2003; Park & Armstrong 2017). This, in turn, has implications for their popularity and the acceptance of some models over others, e.g. swapping versus renting.

Table 1. Terminology – Collaborative Consumption
(adapted from Belk 2014; Hamari et al. 2015; Benoit et al. 2017).

THEME	KEY TERMINOLOGY	SOURCE IN WHICH TERMINOLOGY IS MENTIONED
CONSUMPTION PRACTICES DESCRIBED AS 'SHARING'	• Collaborative consumption • Commercial sharing systems • Co-production • Co-creation (linked to S-DL (service-dominant logic)) • Pro-sumption • Product-service systems • Access based consumption • Non-ownership services • Two-sided market • Sharing economy or Shareconomy • Collaborative consumption	Mont, 2002 Prahala & Ramaswamy, 2004 Vargo & Lusch, 2004 Rochet & Tirole, 2006 Humphreys & Grayson, 2008 Belk, 2010 Botsman & Rogers, 2010 Ritzer & Jurgenson, 2010 Bahrndi & Eckhardt, 2012 Lamberton & Rose, 2012 Wittkowski et al., 2013 Botsman, 2015 Hamari et al., 2015
VIEWPOINTS OF COLLABORATIVE CONSUMPTION	• Sharing • Borrowing • Reuse and remix culture • Charity • Secondhand market and sustainable consumption • Anti-consumption	Hibbert & Horne, 1996 Lessig, 2008 Young et al., 2010 Ozanne & Ballantine, 2010 Belk, 2014 Jenkins et al, 2014

Thus far we have only focused on *collaborative consumption* as an isolated concept, rather than linking it to the wider field of the sharing economy. Within the academic literature both the sharing economy and *collaborative consumption*, have received an increased interest across a multitude of different fields. It may be unsurprising that various terms have emerged that all describe similar consumption practices, all of which have ‘sharing’ as a common theme. An explanation could be that ‘sharing’ practices, and *collaborative consumption* more specifically, lack a clear-cut definition, which implies that the lines are blurred as to what *collaborative consumption* actually is. Reviewing the literature further, *collaborative consumption* can be researched from a variety of different viewpoints, which further adds to the complexity of the topic. Table 1

Table 2. Overview of collaborative consumption services
(adapted from Armstrong et al. 2015; Park & Armstrong 2017).

MODES OF EXCHANGE	TRADING ACTIVITY	MONETARY TRANSACTION	MODE OF ACCESS	FORMAT
ACCESS OF OWNERSHIP	Renting	Yes	Temporary	Business- to Consumer or Peer-to-peer
	Lending	No	Temporary	Peer-to-peer
	Borrowing	No	Temporary (in some instances return not expected, e.g. piece of paper)	Peer-to-peer
TRANSFER OF OWNERSHIP	Donating	No	Unlimited	Consumer-to-business
	Purchasing pre-loved garments	No	Unlimited	Business- to Consumer or Peer-to-peer
REDISTRIBUTION	Swapping	No	Unlimited	Peer-to-peer

provides a brief summary of key terms used within the context of *collaborative consumption*. It has to be highlighted that Table 1 is not based on a systematic literature review, but rather was added to illustrate the complexity of the topic area and provide a basis of discussion.

Aside from the notion of ‘sharing’, Table 1 further highlights that sustainability features are dominant within the references associated with consumption practices and the viewpoints of *collaborative consumption* (Piscicelli et al. 2015). Sustainability here is defined in accordance with Elkington’s (2004) Triple Bottom Line, which suggests a three-pillar structure focusing on social, environmental and economic aspects. To reiterate this further, key to both the sharing economy, of which *collaborative consumption* is a part of, is the reduction of waste and the delay in discarding products, in this case garments, for as long as possible.

Overall, it can be said that the sharing economy and *collaborative consumption*, share two key similarities: first, consumers are able to access goods (garments, accessories) without necessarily acquiring ownership, and second, they have thrived through Web 2.0 and the emergence of peer-to-peer platforms (Belk 2014).

Examples of collaborative consumption – swapping in the UK

Although *collaborative consumption* has accelerated since Web 2.0, different business models exist that facilitate both online and offline ‘trading activities’, which allows for an inclusive approach. Hamari et al. (2015) started to map 254 consumption services in their study dividing them into two modes of exchange and multiple trading activities that can have a monetary transaction attached to them or not. Table 2 is an adaptation of their overview, with the addition of redistribution of ownership discussed by authors, such as Armstrong et al. (2015) and Park and Armstrong (2017).

It is argued that although ownership of garments change hands during swap shops, they can also be returned at any point in time and swapped for yet another garment or swapped back by the original owner. Thus, ownership is redistributed for an unlimited time rather than fully transferred. As such, this mode is rather unique and provides interesting avenues for further studies.

A key question that may emerge at this stage is why explore *collaborative consumption*, and specifically swapping behaviour, in the UK? What makes this topic interesting and significant? From an economic perspective the sharing economy, which includes swapping and renting, facilitates €28bn worth of transactions within Europe alone (ONS 2017). This clearly highlights that this industry sector is of growing importance. The Office for National Statistics (cited in Daneshku & Vandeveld 2016) further indicates that whilst retail shopping has seen an increase of 4% overall, spending on footwear and clothes has decreased by 4%. This further suggests that consumers may look for alternatives to purchasing new fashion items in traditional high street shops or online and engage more with the *collaborative consumption* phenomenon, which would link to and further support the fact that they are disruptive innovations (Markides 2006).

In the UK market, swap shops are increasingly popular with websites such as 'Love your Clothes' or 'Swishing' providing information on how consumers can set up their own swaps, as well as informing them about events happening in their local area. Clothes swapping implies that people meet either online or in person and exchange garments, without making any monetary transactions (Perlacia et al. 2016; Battle et al. 2018). Yet, the latter aspect might be slightly misleading, as participants do not have to pay for the items swapped, as they are simply trading in their own clothes and gain new garments, however the actual event may have a small fee attached, which allows organisers to cover their overheads. Although consumers seem to be wary of swapping events, as they are relatively informal and unstructured (Armstrong et al. 2013) they have been increasingly popular, especially amongst millennials and during Fashion Revolution Week, which marks the anniversary

of the Rana Plaza Factory accident that saw thousands of people lose their lives (Tuttle 2012; Parveen 2014). Indeed, it is events such as the Rana Plaza factory collapse in 2013 that have really brought the negative side of the fashion industry to light, thrusting issues such as poor working conditions, low wages and other ethical issues such as slave/child labour, alongside the negative environmental impact, into the media spotlight around the world. The increased awareness of such issues have created a more conscious consumer, particularly amongst the millennial generation, whereby the move for change in consumption practices is gaining momentum.

Although swap shops are becoming increasingly popular, this is not yet been reflected in mainstream research. We would, thus, like to take the opportunity to raise a couple of key questions and discussion points that may encourage future explorations in this area. When observing swapping events we found that people have different 'strategies' in terms of when they arrive at the event, how they search for clothes and how long they stay for. A question that emerges here is whether there are consumer typologies emerging and whether these are also reflected in their every day behaviour. This aspect is of importance as it would also shed light on sustainable behaviour and green consumption, with Young et al. (2010) pointing out that there are a variety of shades of green consumers, yet their study excluded fashion products. A further enquiry could investigate the underpinning motivations of participating (or not) in swapping events. Although authors (Armstrong et al. 2015; Park & Armstrong 2017) have started to problematize the sharing economy and *collaborative consumption*, research thus far lacks an exploration into the underpinning drivers and barriers. This issue is important as sustainability, and more specifically sustainable consumption, has become a top global priority for the UN (2018).

Conclusion

This chapter provided an overview of *collaborative consumption* by offering an insight into current debates on its definitions and the variety of terminology used to discuss this emerging phenomenon. Although *collaborative consumption* is not as mainstream in the fashion industry as it is in the tourism and transportation industry, it has seen some success stories that are continuously growing, indicating that it has potential. Further research is needed into this area in light of the recent rise in media coverage associated with these disruptive innovations ranging from safety issues (e.g. in Airbnb accommodation), assaults (e.g. towards and from Uber drivers), as well as recent bans of some of these platforms in countries such as Denmark. There is a question of whether any of these issues will affect the fashion industry, seeing as many of the issues raised relate to the close proximity of the user and those providing the good and/or service, yet this is slightly different for the fashion industry, therefore requiring future research.

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Design Strategies

04

Designing for a Circular Economy: Make, Use and Recover Products

Ruud Balkenende, Conny Bakker

Design for a circular economy emphasises the importance of recovery of products and materials, if possible, through maintaining the performance and value of a product over multiple use cycles. Preferred recovery operations are reuse, repair, refurbishment, remanufacturing and parts harvesting, as these processes maintain or restore the functionality of products and parts. Furthermore, enabling the recycling of materials is an essential step, although also a last resort. In design this brings about the need for strategic thinking and a long-time horizon with increasing attention to business models.

Keywords: Product design, recovery, circular economy



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Introduction

Instead of “less is more,” we can now say: “endless is more.”

(William McDonough, <https://www.greenbiz.com/article/davos-meets-circular-economy>)

Through the design of products, materials are shaped and combined with other materials, often in a complex way, leading to highly integrated products. The energy and effort put into the sequence of manufacturing processes determines the functionality, quality and value of a product. Surprisingly, at the end-of-life of a product we take it for granted that its functionality, all the energy put into manufacturing as well as its value will be lost. Most products are simply wasted, i.e. land-filled or incinerated. This leads to a large environmental burden and significant economic loss. To avoid this, the recovery of products and their constituent materials should be explicitly addressed in the design of products. Although recycling is receiving increasing attention, implying that at least part of the materials and a fraction of the value are recovered, this hardly reduces the losses. To maintain environmental quality and economic value, dealing with products in a different way is a necessity. Repairing a product that is broken or upgrading a product that is still functional. This asks for a change in the way in which products are designed, made, sold, used and treated at the end of a life cycle. This is essentially what circular product design is about. In this chapter we will outline how the principles of circular economy can be implemented in the design of products and services.

Designing for a circular economy

Starting with the broader context, the major driver of the transition to a circular economy is the need for a more sustainable world. We face a number of urgent global problems that are summarised in the United Nations Sustainable Development Goals. Design offers great opportunities to improve the environmental performance of products. This has been the focus of design for sustainability over the past 25 years. Design for sustainability integrates environmental aspects in the design of products and services and aims to reduce negative environmental impacts while maintaining the performance of a product. In practice the focus has been largely on optimising the material usage and energy consumption of products, and on increasing the amount of recycled materials. This has led to considerable improvements in the design of products, in part also stimulated by regulations that have enforced companies to follow an eco-design approach. However, results are only implemented at an incremental pace, and as our challenges have increased new technologies have emerged. Instead of trying to solve environmental issues we should step up to preventing them. It is time for a next step in design for sustainability, and it is time to increase the impact of what designers do. This is where design for a circular economy comes in. Instead of saving just materials, we can save functionality and value. To achieve this, the loop must be closed at the level of the user, the level of the service provider or the level of the manufacturer. This will only work when not only environmental impacts, but also business and user aspects are taken into account. This means a more complex approach, which is strongly promoted in design for the circular economy.

Circular economy is not yet a well-defined scientific concept. A recent paper (Kirchherr 2017) made an inventory and found 95 different definitions. Therefore, it is necessary to clearly describe what we consider the core values of a circular economy. We will not do this by adding another definition but by noting the aspects that we consider

essential. First the ultimate aim of CE: this is sustainable development, implying environmental quality, social equity and economic attractiveness. The positive economic approach, in particular, makes CE stand out. Increasing product lifetime by making products more durable and by enabling recovery of product functionality, not only minimises environmental impact, but also has the potential to maximise economic benefit. This perspective helps companies to see the opportunity to really combine sustainability with a business approach that is versatile.

All this requires taking a systemic approach, a second essential aspect of CE. It has been inspired by influential holistic strategies, like *Biomimicry* (Benyus 1997) and *Cradle-to-Cradle* (McDonough & Braungart 2002). These aim for closing resource loops by optimizing systems instead of improving the components within a system, and have inspired many companies and designers to explore new solution spaces. The high level of abstraction of these strategies, however, makes



Figure 1. Aspects that we consider essential to the concept of Circular Economy.

it difficult to directly implement them. Although inspiring, they also tend to be dogmatic, making practical application difficult for many companies. In contrast, circular economy provides a more pragmatic approach, recognizing that closing loops from a business perspective requires addressing not only material related issues, but also business models, logistics and financing, and actively encouraging companies to explore new directions that explicitly include recovery.

Recovery is a third essential aspect of CE. The emphasis on creating opportunities for reusing or remaking a product by recovery operations like reuse, repair, refurbishment, remanufacturing and parts harvesting is a distinguishing aspect of a circular economy compared to the traditional linear economy. For these aspects to work, we need knowledge that enables practical implementation, for instance regarding sustainable business models, or regarding technological developments in manufacturing, data acquisition and data management. The final core aspect, often undervalued, is the way people deal with products and services, their behaviour and their acceptance of new offerings.

The implications of the transition to a circular economy for product and service design are considerable. Although product design already integrates knowledge of people, business and technology, our current way of designing misses out on the recovery of products and materials. Therefore, two basic questions that should be addressed from a circular product design perspective are:

- How can we change the design process of products and services to make recovery an integral part of design?
- And how can we implement this in the actual design process as it takes place within companies?

Because only then will circular product design be able to reach scale and have a real impact on society. In this chapter we will focus on recovery (the first question) as an integral part of the design process.

Recovery as an intrinsic part of design

The classic product innovation process models that have been developed over the past 40 years (see example in Figure 2) describe how product development moves in a relatively straight line from a strategic stage, where the need for a new product is determined, to the more operational stages concerning detailed design, production, marketing, distribution and eventually, product use. None of these models, however, considers how a product can be recovered at the end of its functional life.

Adding the recovery step to the strategic models of the product innovation process is a crucial addition (see Figure 3). The recovery stage describes what happens to a product after ‘use.’ It includes reuse, refurbishment, remanufacturing and recycling. Designers use models like these to plan and organize the design process, and to discuss and communicate the various steps with each other and with clients. They also use the models as checklists when drawing up a program of requirements. In other words, these product innovation process models are part of designers’ mental models of the design process – they form a kind of shared language. And when a step such as recovery is missing from these mental models, it will not be addressed during design, at least not structurally, risking the situation that topics such as sustainability and circularity will not exert strategic influence on product policy and product planning beyond legal compliance.

Just as technology links user and business from the perspective of manufacturing and functionality, so does recovery link user and business from the perspective of a complete and closed life cycle. In circular product design it is essential that such a life cycle perspective is already present at the initial conceptual level of product design. Adding recovery thus implies that all actions that might be needed after the use of a product should always be taken into account. By making circularity an explicit but integrated part of the design concept, opportunities to start a new cycle instead of wasting the product will become part of the

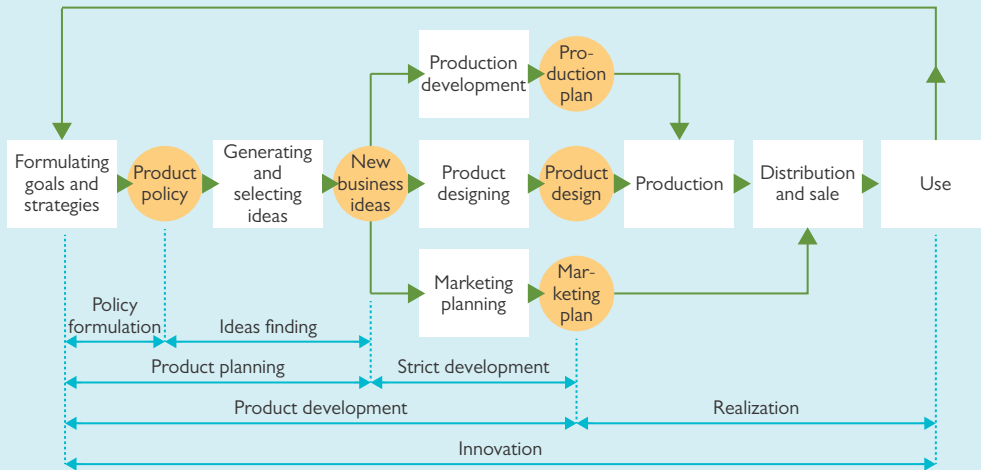


Figure 2. The original Product Innovation Process model by Roozenburg and Eekels (1991). The product recovery step, after ‘use,’ is missing.

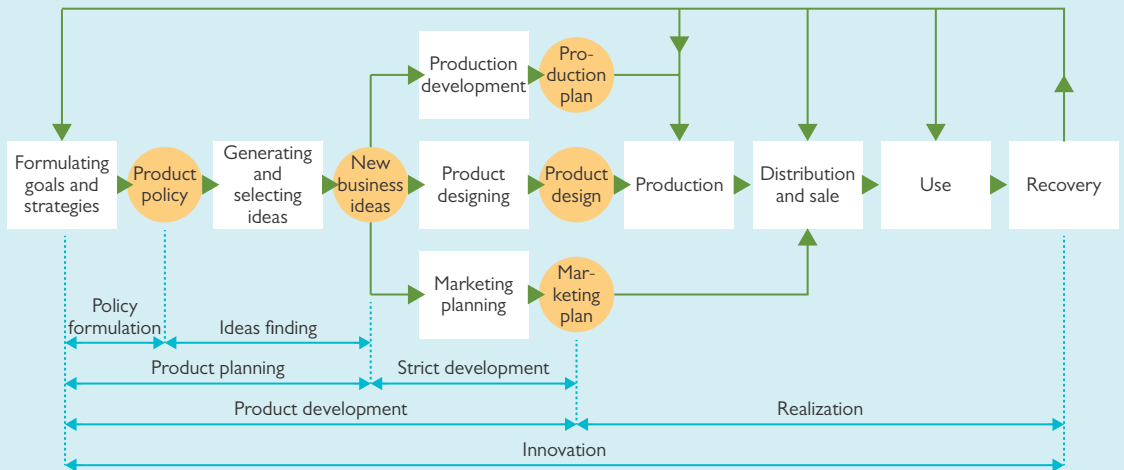


Figure 3. The adapted Product Innovation Process model, with the recovery step added (by Bakker).

earliest stages of product design. To achieve this, a variety of opportunities exist to reuse the product, either directly, through repair, refurbishment, remanufacturing or parts harvesting, or indirectly through materials recycling.

In the following we will explore opportunities for design and illustrate these with examples. The examples are taken from a diversity of cases, the underlying way of thinking about effects at the system level and the integration of business, technology and human aspects, however, can be transferred to many other types of products and services.

Material recovery: Recycling

Recycling is the outer loop of circular economy. Materials are recovered, but product functionality is lost (Figure 4). It can be considered a last resort, but recyclability is also a prerequisite for any product once extension of its useful life is no longer possible. The first step in the recycling process for most products is shredding. This is a very forceful treatment of a product, consisting, for example, of hammering or cutting, with limited control over the final result. The purpose of this process is to yield fragments that are sufficiently homogeneous to be suited for subsequent sorting and further processing, in which the actual material recovery takes place. Almost all consumer goods, whether a phone, a hairdryer, a pair of jeans, or a fridge, end in this way. So, designing for recycling essentially means designing for shredding.

Let's take as an example a simple lamp, an LED spotlight (see Figure 5, top left), which basically consists of an LED board (that contains the LED lights), a heat spreader, an electronic driver for the LEDs and connector pins. This lamp type has been extensively investigated in the European GreenElec innovation project, which ran from 2011 to 2015, and aimed to improve the recyclability of small electronic products (Balkenende 2014). The fragments that result after shredding the LED lamp are not homogeneous but contain many different materials that are stuck together and cannot be recycled simultaneously. The electronics

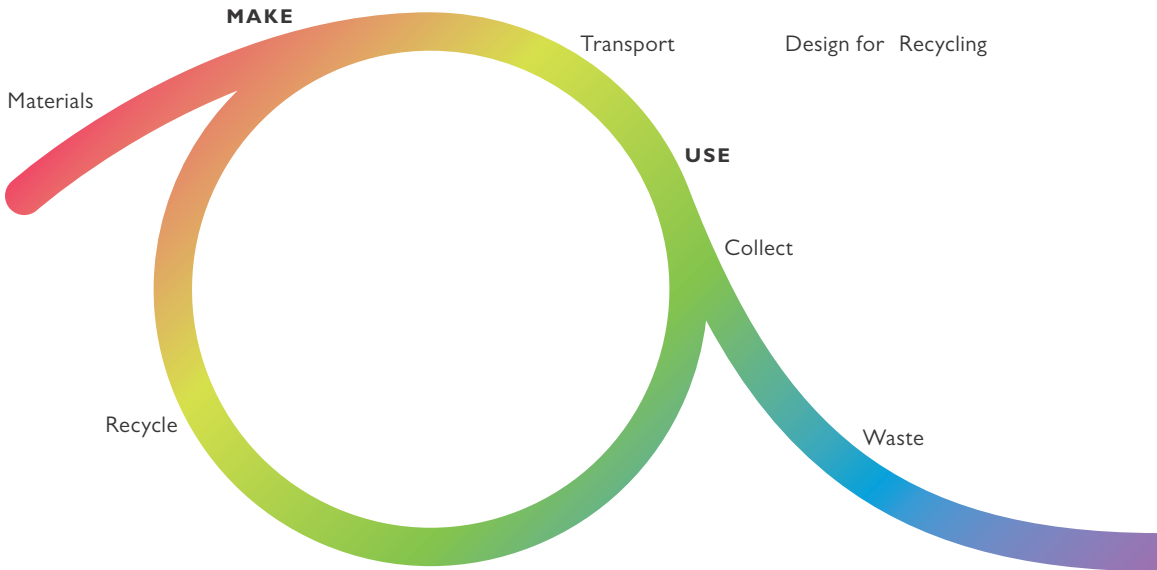


Figure 4. The product life cycle for products in a linear economy. Although recycling takes place to some extent, from a design perspective the result is often coincidental.

for instance largely remain fixed to the aluminium heat spreader due to the screw connections between them. This is problematic, because aluminium and printed circuit boards need to be separated in order to be successfully recycled. With this specific product, about 40% of the weight, mainly aluminium, is recovered in the end. However, most of the more valuable materials present in the electronics (such as copper, silver and gold) are lost.

The lesson learned is that it is not sufficient to have products with only recyclable materials; in the recycling process these materials should also become disconnected, because otherwise they cannot be recovered. A number of LED lamps were redesigned taking these two simple rules



Figure 5. A LED spot light (top left) and three redesigns employing different materials and connections to improve the recycling result. The images at the bottom show typical fragments resulting from a shredding test. Recovered fractions are given in weight-%.

into account: the lamps consist of recyclable materials and they have connections that break easily in the recycling process. This resulted in a variety of design solutions. In the existing LED lamp, the focus was on breaking down the screw connection during the shredding process. This was achieved by adding fracture lines along the screw holes. The fracture lines guide fragmentation during the shredding process (without hampering reliability during normal operation). A shredder test resulted in considerable improvement of the homogeneity of fragments and

therefore much better separation of different materials, with 70% of the materials recovered (see Figure 5).

In the subsequent redesigns of the lamp, the requirements regarding recycling were already considered at the start of the design process. The internal connection was completely eliminated, and different material choices were made. The redesigns have been described in more detailed elsewhere (Aerts 2014), but here we summarise the main results. In the redesigns, no fixed internal connections were used, and the housing material was made more uniform to eliminate the non-recyclable plastic originally used. Small-scale shredding tests showed very convincing results with recovery of 80 to 90% of the materials. In both cases most of the LED boards were released and could be separated. Furthermore, the cost of the newly designed lamps were the same or lower than that of the original. This implies that such redesigns are attractive from the perspective of the manufacturer and contribute to improved revenues once it comes to recycling. By setting the problem in the right way and dealing with it in the early design stage, a new solution space was opened up.

In design for recycling, special attention should be given to the use of highly tailored ‘materials’ that are crucial to many applications. What we call a material is actually often a complex combination of a number of materials. Composite materials, which have unique properties that can be tailored to a large extent to make them very suited for specific applications, are a prominent example. This ranges from the complex layered structures used, for example, in airplanes and wind turbine blades to the elastomer coating on textile fibers. Electronics, where up to 50 different elements are highly integrated in small volumes, form another example. Additional complications arise when embedding electronics in all kinds of products, for instance by adding sensors and connecting them to the Internet. Luminous textiles in which electronic wiring and LEDs are interwoven with the fabric, and the incorporation of electronics in objects made by 3D printing, are other examples where the degree of integration will hamper the proper end-of-life treatment of a product. We encounter these materials

in textiles, furniture, electronic equipment, but also in cars, airplanes, wind turbines, and even in bridges. In most applications these materials are essential for performance and therefore difficult to replace. Due to their tailored properties, reuse is very difficult and unfortunately, due to the mixing of materials, recycling is almost impossible. Here new design strategies need to be developed that already consider next use cycle of the materials when designing products which employ them.

Through design for recycling we can ensure that the materials in a product are recovered as best as possible. Applying recovered ('recycled') materials in new products is also an important part of design for recycling. An inspiring example in the field of textiles is the use of 100% recycled yarn by Interface, a global manufacturer of carpets, in their Net Effect tiles (Pauw 2015). The nylon of these tiles is sourced by collecting discarded fishing nets from oceans and beaches. In addition to the use of recycled nylon, a random pattern is applied in a smart way, hiding quality variations in the nylon. Further, Interface started applying polyvinylbutyral, obtained from recycled car windows, to replace the latex in the precoat that takes care of adhering the yarn to the tile backing. This decreases the environmental load of the precoat by 80%.

Product and part recovery: repair, refurbishment, remanufacturing and parts harvesting

To maintain or recover functionality at the end of the life cycle of a product, i.e. to enable a subsequent life cycle, products can be reused, repaired, refurbished or remanufactured. If complete products cannot be recovered, it might be worthwhile to harvest some of their parts and refurbish or remanufacture them (Figure 6). Repair, refurbishment and remanufacture are differentiated according to the quality of the recovered product relative to the original. In the case of remanufacturing, the product gets an extensive overhaul and is brought back at least to

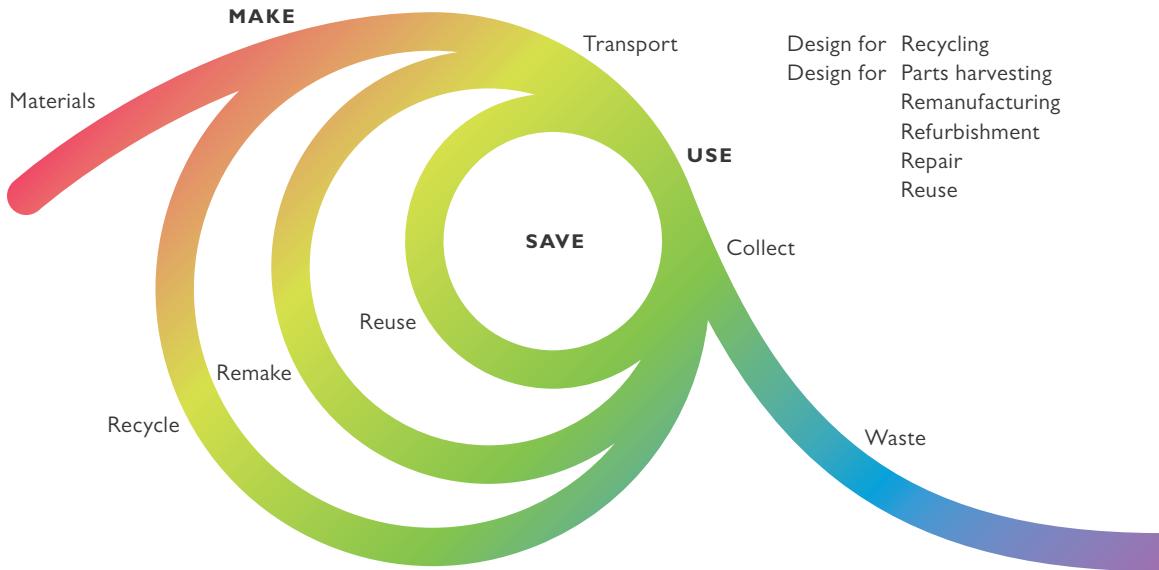


Figure 6. The product life cycle for products in a circular economy. The emphasis is on keeping products and materials in use through recovery operations.

Original Equipment Manufacturer (OEM) specification (Hollander 2017). In the case of repair and refurbishing, the process is less comprehensive and the condition of the repaired or refurbished product may be inferior to the original specification (Gray 2007). The handling and treatment of a product at the end of a life cycle is to a large extent similar, although repair is usually a limited operation (e.g. fixing a flat tyre or replacing a broken zipper) whereas refurbishment and remanufacturing require more elaborate processes, involving operations like disassembly, cleaning, inspection, diagnosis, testing, upgrading, aesthetic touch-ups and reassembly. Design should therefore optimally allow for such operations.

Repair

Design for repair tends to focus on self-repair by product owners. Typical design for repair criteria are the use of standard, universally applicable components and the use of standard interfaces to enable the quick replacement of broken parts with a minimum number of tools. Other criteria include the provision of (free) repair instructions and the design of 'use cues' in the product that guide repair. Also, it is considered important that the most fragile parts (liable to break or wear down) are easy to access and handle. However, this design for repair approach strongly focuses on self-repair and neglects serviced repairs. The comparison between smartphones from Fairphone and Apple is interesting in this respect. The Fairphone II (a smartphone designed by a company in the Netherlands) is built in a modular way, with a relatively low level of integration. Easy accessibility and facile replacement of all modules is enabled. This allows easy repair and even upgrading of parts by the user. Apple's iPhone X on the other hand has an integrated design: the interior of the smartphone is almost inaccessible unless special actions with specific equipment are carried out. Even if the interior of the phone is accessed, the way in which modules are connected make this product very difficult to repair by ordinary users. However, repair is still straightforward for an expert repair service, the advantage for the company being that the quality of repairs can be guaranteed. Also, the reliability and durability of the product is related to the quality of its construction. From a sustainability point of view this points to an interesting trade-off between durability and reliability as such, and ease of repair.

From a circular economy perspective both approaches can be seen as different routes towards a longer than average product lifetime. Which approach is preferable from a sustainability point of view? Interestingly, both approaches can be justified. It will depend on the business model as well as on the behaviour of the user. Fairphone has chosen to operate in an open system, where the input and active participation of others is crucial. Fairphone has used design explicitly to enable its users to take actions that are necessary to recover the product. This also means that its

customers need to act accordingly. This is a model that will work well with sufficiently motivated users. Apple on the other hand targets users who desire a high-end phone which is built for performance. Apple has opted to operate in a fairly closed and controlled system. The user is dependent on Apple or qualified repair shops to restore the product if it fails. Such a controlled closed system can be a perfectly valid approach, also from a sustainability perspective, but the model only works when the manufacturer takes full responsibility for recovery of the product and enables the user easy and affordable access to repair. To summarize, two different design approaches to repair which can both be successful when it comes to product lifetime extension. But to be successful, they both need to explicitly take into account the opportunities for recovery at the end-of-life of the product, not only from a technological perspective, but also involving business model and user involvement.

Refurbishment, remanufacturing and part harvesting

Refurbishment, remanufacturing and parts harvesting close the product loop at the level of the manufacturer. The success of these recovery strategies depends on the long-term vision of and the responsibility taken by manufacturers. By their nature these operations require foresight and planning regarding business perspective and developments in product design. Offering products in multiple use cycles will only succeed if these recovery strategies are an integrated part of the business model and product design.

Refurbishment and remanufacturing imply that used products are collected, involving reverse logistics, and subsequent disassembly. The resulting parts and modules are then cleaned, inspected, and if necessary repaired, revised, and sometimes adapted, replaced or upgraded. This is followed by the re-assembly and testing of the system. Product design should facilitate the refurbishment and remanufacturing process, including component durability, ease of disassembly and reassembly operations, accessibility, and cleaning, but also reverse logistics and

marketing (Shu 1999; Nasr 2006). Most of these concepts are familiar in common product design but are now applied with a different aim. As an example, modularization and platform design are commonly intended to improve production efficiency and lower costs, for example enabling an extended product family while building upon a limited set of modules. Although future generations might use the same set of modules, planning is usually limited to a 3 to 5-year time-frame. In remanufacturing the focus will change to efficient disassembly and process organization, where a time horizon of at least 10–15 years should be considered.

Neopost, for example, designs and manufactures a variety of products to facilitate mail management, such as franking machines. In 2012, the company undertook an ambitious remanufacturing strategy. Instead of selling their franking machines they now offer them as a service through lease contracts. The products are designed with a time horizon of 10 years, in order to facilitate two commercial life cycles of five years. Neopost needed to think about the upgradeability of the electronic motherboard in the current range. The functional requirement is 32MB whereas the next generation is likely to be 64MB, so to provide the possibility to rework the Printed Circuit Board Assembly (PCBA) the design team opted for a 64MB at the outset. This shows how the designers had to think ahead and plan for the multiple use cycles of the franking machine (ERN 2018).

While remanufacturing is typically controlled by OEMs or OEM-licensed third parties, refurbishment is more often done by unlicensed third parties, the so-called Gap Exploiters: entrepreneurs who exploit leftover lifetime value in products (Hollander 2016). Refurbishment of smartphones, for instance, is a rapidly growing market. In 2017, the global market for refurbished smartphones grew 13%, whereas the market for new smartphones only grew by 3% (Kang, 2018). The refurbished phone market is now 10% of the total global smartphone market, with refurbished phones available in many different grades and qualities and advertised with poetic qualifiers such as ‘reborn,’ ‘pre-loved,’ or ‘certified pre-owned.’ This is a marker of the success of the

circular economy but it also requires vigilance, because consumers are increasingly confused with the different quality indicators leaving open a risk of back-lash if poorly refurbished devices flood the market. The example shows again that OEMs (and designers) need to plan for the future use-cycles of their products, in particular those with a high resale value, such as smartphones. They need to recognize the possibility that their devices may be repaired and refurbished by unlicensed third parties or consumers and plan their design and business model accordingly.

Parts harvesting is the retrieval of components, modules or parts from obsolete products with the purpose of using them as spares, parts for servicing, maintenance and repair. From the perspective of the parts supplier, the harvesting and revision of parts can be considered as equivalent to remanufacturing. This is quite common in the automotive industry, for ICT equipment and professional machinery (ranging from heavy duty machinery to medical equipment). Parts harvesting is often closely connected to refurbishment and remanufacturing, with which it has most of the associated design principles in common.

Product recovery strategies are mainly observed in the case of capital-intensive business-to-business (B2B) products, like medical scanners and heavy machinery. The automotive industry provides an interesting example, where remanufactured parts purchased at the aftermarket often replace defective parts. After repair, the replaced part is returned to a remanufacturing plant against a financial incentive. Although in this example, the harvesting and subsequent remanufacturing of parts takes place in a B2B environment, the operations concern a consumer product.

Conclusion

Design for CE puts attention for product life extension and recovery firmly on the agenda, with some surprising new insights for design. One of these new insights is the need for a long-time horizon, beyond product use and towards multiple use cycles, i.e. foresight. This needs to be reflected upon in the strategic stages of the product innovation process and may eventually change the role of design to become more strategic. Related to this is the need for designers to engage with business models. Repair and refurbishment examples show that the meaning and implications of these processes can be different in different contexts. Basic aspects here are related to ownership of the product, the responsibility for the recovery processes, and execution of the recovery processes. Designers need to be aware of these aspects and take them into account in the early stages of product design. Lastly, design for recycling needs to mature. Recycling technology is rapidly developing, and designers cannot afford to be ‘out of the loop.’

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Design Strategies

05

Design for Circularity: The Case of *circular.fashion*

Essi Karell

What does it mean in practice to design clothes that at their end-of-life could be circulated into new fibers, yarns, fabrics and textile products? This chapter addresses the question through a descriptive case study of a sustainable design consultancy *circular.fashion* which has developed a novel approach to circularity. Multiple challenges and solutions regarding circularity within the company practice are introduced and reflected upon with respect to different phases within the circular textile value chain and previous literature. The chapter contributes to a deeper understanding of required changes in clothing design practices when aiming to accelerate the transition from a linear production–consumption system to a circular alternative.

Keywords: Design for circularity, circular fashion, circular design strategies, chemical fiber-to-fiber recycling



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Introduction

Fundamental problems within the fashion industry originate from the pace of production and consumption, which further brings forth many environmental and societal crises. Fortunately, the problems are being increasingly recognised by various stakeholders throughout the fashion value chain. This can be seen in the growing interest in the circular economy (CE), which has been recognised as a viable concept towards a more sustainable production-consumption system.

CE is an economic model that is restorative and regenerative by design (Ellen MacArthur Foundation 2012). The concept builds on various ideologies and approaches, from which *cradle-to-cradle* by Braungart & McDonough (2002) is probably the most well-known. In the cradle-to-cradle approach, technical and biological materials are viewed as nutrients (excluding harmful chemicals) that can circulate infinitely creating closed material loops in a waste-free system. The closed-loop system provides countless steps to add value to products and materials, upon which the global fashion industry also depends when taking into account the decreasing virgin resources.

When envisioning the future without textile waste, *closed-loop recycling* (CLR) is required. As emphasised by Payne (2015, 111–114), closed-loop recycling in the fashion industry can be defined in many ways. One definition refers to recycling methods, through which the waste textile is reused in the garment production chain (ibid.). It includes, for example, remanufacturing and the mechanical fiber-to-fiber recycling of textiles. Also, the reuse of garments (second-hand market) can be considered an example of closed-loop recycling as the “product may enter a new life cycle within the same production chain” (Payne 2015, 114). Thirdly, and the most radical means of CLR, is linked to the cradle-to-cradle method (Payne 2015). In this approach, infinite material recycling becomes possible through chemical fiber-to-fiber recycling. It indicates processes where textile product can be broken down to a fiber level and reprocessed into a similar or higher quality textile application than before. In this chapter, closed-loop

recycling based on the cradle-to-cradle method has been chosen as the basis of discussion.

When illustrating closed-loop models, the interrelations between different stakeholders within the fashion value chain are easier to perceive than in the current linear value chain. Everything effects everything. This relatedness also obligates designers to participate in the discussion of a circular economy. As reported by Elander and Ljungkvist (2016, 51), fashion companies represent a stakeholder group able to influence most aspects of the circular textile value chain. Hence, approaches to new product design are critical in supporting recyclability (Kant Hvass 2016). But what will this actually imply regarding fashion designers' daily practices? What does it mean today when the ambition to move towards CE is only just emerging?

This chapter presents a case study that provides understanding of the systemic challenges for textile circularity and how they relate to designers' work. Berlin-based sustainable design consultancy, *circular.fashion*, has developed a novel approach to circularity and thus embodies multiple ways to address the barriers to it. A descriptive case study[★] of *circular.fashion* examines the company's philosophy and practices when designing for closed-loops. The case reveals challenges and solutions in circular fashion design practices which are addressed in respect to different phases within the circular textile value chain.

The current study aims to provide solutions to how to contribute to CE through design, and supports the ideation of an alternative design practice. New technologies are constantly emerging, and commitment to CE throughout the industry is increasing. The situation pictured on

★ The intent of a descriptive case study is to understand a specific issue, problem or concern (Creswell 2013). In the case of *circular.fashion*, the issue at hand is the overall challenge of design for circularity in such a complex system as the clothing industry. *Circular.fashion* can be labeled as an instrumental case as it holds potential to provide insights that can go beyond the case at hand (Lazar et al. 2010).

the following pages is a snapshot of the design consultancy and its practices at a specific time and place.** As Niinimäki (2017) states, examples of real life design are needed to support the change on multiple levels towards CE. With its novel approach, *circular.fashion* can be considered a crucial example.

Challenges for textile product circularity

There are many challenges in the chemical fiber-to-fiber recycling of post-consumer textiles. Following Elander and Ljungkvist's (2016) expert interview study, some critical aspects are specified below based on four categories: Material input for recycling, markets, information, and technology.

First, however, it is important to picture the state of legislation in textile recycling. As noted by many (e.g. Hvass 2014; Payne 2015; Bouzon & Govindan 2015), legislation is an influential driver regarding the practice of reverse logistics and, consequently, effective recycling systems. For example, in the European Union common legislation for textile waste management is currently lacking, and regulations vary between countries. Yet, in February 2018 the Council of the EU

** The case study of *circular.fashion* was conducted between January 2018 and March 2018. The data is based on interviews with the company founder Ina Budde. Interviews were conducted by email (23.01.2018) and through Skype conference calls (29.01.2018 & 09.03.2018). The first Skype call interview was transcribed. Emails and the transcription in combination with the company's marketing material were analysed based on open coding (more precisely descriptive, in-vivo and process coding). Codes were categorised thematically and used for researching links between challenges, solutions and future visions. A holistic approach was taken for the analysis, meaning that the case was viewed as a whole rather than as separate units of analysis. Reporting is based on thematic categories.

published a press release about a provisional agreement on the waste package, which was described to “lead to more recycling of waste and contribute to the creation of a circular economy” (The Council of the EU 2018). If the agreement passes it implies that member states will have to set up, by 1st of January 2025, a separate collection for post-consumer textiles (ibid.). How this would ultimately effect the disposal practices of European consumers remains to be seen. At least from the perspective of other stakeholders in the fashion industry, this holds potential to develop functional reverse supply chains and re-arrange industrial operations – at least within the European Union.

Material input

Regarding materials, the low volume of textiles suitable for recycling is one of the main challenges (Payne 2015), while the functionality of reverse logistics is another. Currently, the collection and sorting of textiles is insufficient (Elander & Ljungkvist 2016) despite being based on multiple collection systems. Increasing amounts of fashion companies are setting up take-back systems, but there the challenges that arise are related to textile volumes as well as quality (Hvass 2014). Consumer awareness of the negative impacts of clothing disposal is a further concern (Elander & Ljungkvist 2016). Because consumers are responsible for the products end-of-life, the functionality of reverse logistics is ultimately dependent on their disposal habits.

The efficiency of textile recycling also depends on the design of easy-to-recycle products (Gulich 2006). A major concern is the complexity of textile products due to the use of material blends, layering of different materials, presence of prints, elastane and trims which include chemicals, colours/dyes, harmful substances etc. (Elander & Ljungkvist 2016; Franco 2017; Niinimäki 2017; Wedin et al. 2017). This implies that very limited amounts of textiles are suitable for chemical fiber-to-fiber recycling.

Increasing the volume of suitable textiles requires the commitment of various stakeholders. Each fashion, sorting and recycling company,

however, has their own demands, which complicate industry-wide collaboration. “As there are no best practices available and no legislation to guide the industry, companies are currently alone in developing a reverse logistics system that matches their needs”, as highlighted by Hvass (2014, 425).

Market

The complexity of the fashion value chain and the relatedness of different stakeholders within complicates assessing the functionality and economical viability of closed-loop recycling. When it comes to markets, cost is a serious factor. Sorting and recycling costs are high, transportation costs for textile waste are high and, furthermore, the incentives for investment in textile recycling are lacking (Elander & Ljungkvist 2016). This results in the high price of recycled textiles (Franco 2017) that many small brands or design teams in commercial fashion companies (often under extreme price pressure) cannot afford. Meanwhile, fashion companies perceive there is a limited supply of recycled fibers/textiles available for designing new textile products (Elander & Ljungkvist 2016; Franco 2017). On the other hand, suppliers of recycled textile fibers report the lack of demand for recycled textiles amongst fashion companies and textile producers (Elander & Ljungkvist 2016). This aligns with the statement by Gulich (2006), according to which recycled products are hard to market, exacerbated by high prices (Franco 2017).

Information

In terms of information, fashion companies seem to lack knowledge of collection and recycling aspects of textiles, as well as reverse logistics (Hvass 2014; Elander & Ljungkvist 2016). There is also a lack of information regarding product content (material composition, dyes, chemicals, other substances) (Elander & Ljungkvist 2016, Wedin et al. 2017). Accessing information about the complete chemical content of products is said to be difficult for fashion companies “due to long and

complex supply chains, the discrepancy in national and regional legislation (REACH) and very limited transparency of the chemical industry” (Elander & Ljungkvist 2016). Going further in the textile value chain, the dialogue between sorters and recyclers seems to be missing. Sorters need to know what textiles to sort out in order to match recyclers’ needs and requirements, while recyclers need information about the chemicals used in recyclable textiles in order to regenerate fibers of good quality (Elander & Ljungkvist 2016, Wedin et al. 2017). Moreover, the requirements of both sorters and recyclers would be crucial information for designers in order to effect the sortability and recyclability early on in the design phase.

Technology

Critical aspects regarding technology relate to the readiness level of different processes. Automated textile sorting technologies that could increase the volumes and purity of textile waste sorted for recycling are under development but currently there is none functioning on an industrial scale (Cura & Heikinheimo 2017; Wedin et al. 2017, Circle Economy & Fibersort). In addition, scaling up chemical fiber-to-fiber recycling technologies is challenging due to the lack of investment in recycling technology (Elander & Ljungkvist 2016). Even though the separation of cotton and polyester fibers (the most common fibers on the market) has been recently proven (H&M & HKRITA 2017; Mistra Future Fashion 2017; Palme et al. 2017;), the separation of different fiber types and handling impurities in chemical recycling processes remains challenging.

The case of *circular.fashion*

Company: *Circular.fashion*

Registered office: Berlin, Germany

Established in: 2015

Main service: Design consulting, online tool *Circular.fashion System*

Main product: *Circular.fashion.ID*

Revenue model: Yearly membership fee, price per product and service

In our current planetary state, the idea of a future without waste appears somewhat impossible to attain. Especially if working in the global fashion industry, the picture of a world without resource scarcity and waste requires plenty of imagination, passion, as well as trust in the human capacity to change and to make changes. Dedicated to this idea is Berlin-based fashion designer *Ina Budde*. As a founder of sustainable design consultancy *circular.fashion*, she believes that if every single product around us could be recycled into a product of the same quality we could eliminate the concept of waste and the need for virgin resources. Inspired by the concepts of cradle-to-cradle and closed-loop ideology, *circular.fashion* provides support for fashion companies in the creation of products and systems suitable for CE. Under the umbrella term design for circularity, the company offers consulting, development of recyclable and biodegradable textiles, products and full collections. Additional services to both academia and industry include workshops and trainings focusing on sustainable fashion, circular retail models and systems. At the core of *circular.fashion* is a novel digital system for textile circularity providing one of the best practices currently operating in the fashion industry.

Today *circular.fashion* employs six people embodying different competencies related to recyclable materials and material research, closed-loop design, consumer demands, sustainable business models, reverse logistics, and software development. Close collaboration with material suppliers, material scientists, textile collectors, sorters and recyclers continuously feeds into the company practices and services.

Customer brands of *circular.fashion* are established and mainly producing in Europe. Today, all the company's operations (collecting, sorting and recycling) are also based in Europe. Regarding sorting, the company is in contact both with global and local actors in order to develop a solution that would be globally possible. Current focus is on developing Berlin-based pilots, which can later be transferred to other situations. The aim is to demonstrate that the concept works in regional loops before expansion is considered.

Design for circularity

As there are many ways to define closed-loop recycling, there are certainly many ways to approach and define *circularity*. For *circular.fashion* consultancy, circularity in fashion does not only mean recycling of discarded materials and products based on cradle-to-cradle, but also reusing the existing garments to keep them at their highest value. However, when it comes to *designing* for circularity, the base line for each product should be the suitability for chemical fiber-to-fiber recycling.

Currently, two ways to approach material recycling for designers have been identified (Goldsworthy 2012). The first – *re-active approach* – refers to working with existing material and product streams. These can be linked to various business models such as redesign services, second hand and leasing models but also downcycling of materials through remanufacture (ibid.). In *circular.fashion*, the re-active approach is referred to also as a *transitional approach*. Even though the approach can provide enormous business potential and slightly reduces the amount of waste, it will not change the linear system from within (Budde 23.01.2018). In order to change the system, a *pro-active* approach that follows closed-loop ideology should be integrated into product design from the start (Goldsworthy 2012, Budde 23.01.2018). In *circular.fashion* this means focusing on full material recyclability, i.e. the creation of products that have the ability to be regenerated 100%.

As an innovative solution, *circular.fashion* has developed a web-based tool called the *circular.fashion system*. It is an industry-connecting

platform and tool for all stakeholders to create circular products and to keep them in the loop. The tool can be purchased and used as Software as a Service (SaaS). Today, the service is based on three different pricing models depending on the company size. The system includes two parts *Circular Design Software* and *Reverse Supply Chain Intelligence*, described in the following sections.

Circular Design Software

The *Circular Design Software* is a digital service designed for the pre-consumer phase in the fashion value chain. It assists fashion companies to design circular and sustainable products in a lean and efficient process. The software features three supportive tools starting from *Circular Design Guidelines* that provide hands on descriptions to designers of how to apply various circular design strategies to their products. In the *Circular Material Database*, designers can look for materials that have been approved by the partner network of *circular:fashion*. Designers can contact material suppliers through the software, request for sample swatches and place their orders directly to suppliers. Through the platform, it is also possible to create the final production documents. In the end, *Circularity Check* shows if the designed product is recyclable with the chosen materials. Sometimes, however, it occurs that products such as functional clothing do not fulfill the requirements of any closed-loop recycler. In such cases, *circular:fashion* can link the customer brand with a mechanical recycler, although that is not their first priority.

Reverse Supply Chain Intelligence

The *Reverse Supply Chain Intelligence* is another part of the service focusing on the post-consumer phase of the product. *Circular:fashion* has allocated a closed-loop recycler for every material in their database. A garment that passes the circularity check receives a unique *Circularfashion.ID* – a code that guarantees the product is suitable for chemical fiber-to-fiber recycling. The ID is attached to garments as a woven label

and allows tracking of each item. The labels can be purchased individually or from one of the certified suppliers. The ID can be scanned by end consumers as well as by sorting and recycling companies and it leads the user to the *Customer Interface*. Through the interface it is possible to access the full history of a garment (product content, material composition, care instructions and production network). Additionally, options for updating, reusing or recycling of a garment are available. At the point of product disposal, consumers are advised how and where to return the products through a *Sorting Guide* that is part of the *Circularfashion.ID*. It also provides information for sorting companies to identify the predefined textile recycler from the *circular.fashion* network. Budde provides an example (29.01.2018):

Let's say there's a cellulosic based material and it has a cellulosic recycler allocated. A brand or designer creates shorts. They can decide then which materials they put into the product. For the lining, for the surface material, for the closure. And then the product check will prove if all the different components are possible to go to the same recycler ... If it's not going to the same recycler but they have chosen a design strategy for disassembly – let's say the lining can be detached. Then it's still approved and this information of detaching the lining will be added on to the product info site as well.

Through this step, chemical fiber-to-fiber recycling becomes possible. In the future, the brands may even order the recycled textiles again for their own production.

From challenges to solutions

As mentioned in previous literature, there are numerous critical aspects to consider when aiming for circular fashion through chemical fiber-to-fiber recycling. The descriptive case study of *circular.fashion* reveals many similar obstacles based on the company's experiences but also provides some new ones described on the following pages. In addition, their own practical approaches and solutions to overcoming the issues are presented. These are aimed to assist other designers and design teams to reflect on how they could contribute to circularity.

To help the reader to navigate through the findings, Figure 1 provides an overview of the challenges and solutions. The company aim, *design for circularity* (based on chemical fiber-to-fiber recycling), is placed in the centre of the diagram. The outermost circle demonstrates the different phases in the circular textile value chain. Policy is not regarded as a phase per se but an upper-level influencer, especially when it comes to waste management and disposal practices. Hence, it is located between *user/consumer* and *textile collection & sorting* and remains more distant from the center. The challenges and solutions for circularity identified in the practices of *circular.fashion* are placed in between and in relation to the different phases.

Easing adoption of circular design strategies

A harsh fact is, however, that current products are not optimised for recycling. Apart from those educated in sustainable fashion and textile design programs, general understanding and competence in sustainable design practices seems to be lacking, let alone what it takes to design with a closed-loop mindset. As Budde (23.01.2018) describes:

Many brands want to create sustainable fashion but lack the knowledge of how to design for longevity, adaptability or material circularity or how to access sustainable materials.

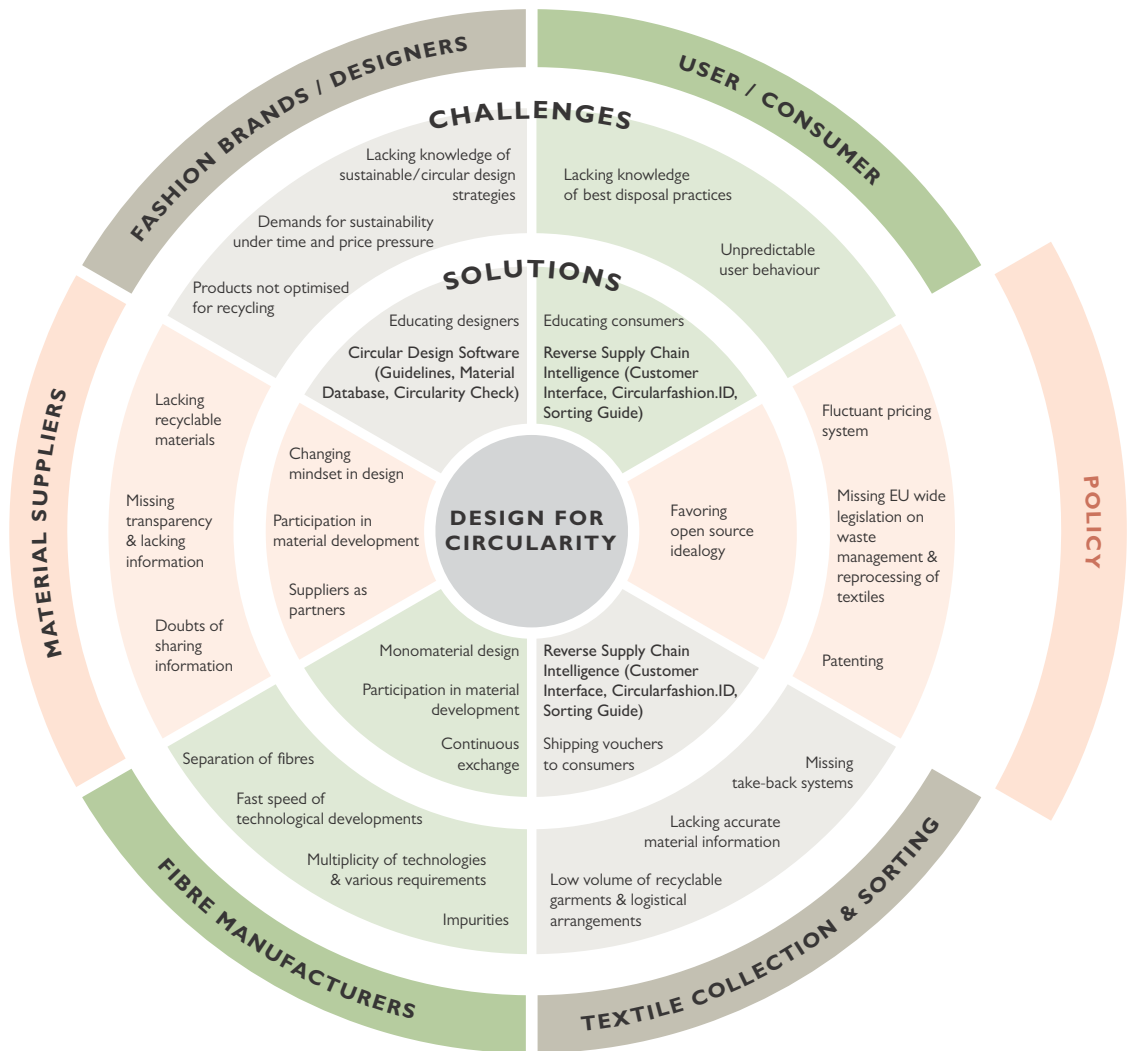


Figure 1. Challenges and solutions identified through the practices of *circular.fashion* when aiming for circular design (illustration by the author).

Meanwhile, design teams working in commercial fashion companies should respond to the pressures of price and production time with sustainable and automated technological manufacturing methods. Calling for sustainability under extreme time and price pressure seems contradictory, but tools like the *circular.fashion system* can supply designers' needs. As part of the *Circular Design Software*, materials and many sustainable design strategies are proposed that enable circular design solutions. Information on the software can be filtered according to designers' interests. For example, designers can choose whether to investigate material cycles such as cellulose, polyester or biodegradable substances. They can also filter materials according to the country of production, characteristics, composition, fabric type, pattern type and color. Regarding strategies, filtering can be done based on material cyclability (e.g. monomaterial design, design for disassembly), material cycle (recyclability or biodegradability), design for adaptability (e.g. modular design, multi-functional design, adjustable sizes), design for longevity (e.g. repairability, aesthetics, emotional durability) and also product types (Budde 29.01.2018.)

After filtering, compatible strategies are displayed. They are further illustrated as design briefings because designers are used to being briefed on what to do (Budde 29.01.2018). Figure 2 illustrates a briefing of emotionally durable design. In other words, each strategy has its own translation. This eases and speeds up the adoption of strategies, but also differentiates *circular.fashion* from other initiators promoting sustainable/circular design strategies. Regarding emotionally durable design for example, it can be hard to imagine what a designer should actually do. Budde (29.01.2018) explains it as follows:

We always have an example next to the strategy ... a very specific product and how it was solved or what was the idea behind this product.

Figure 2. Briefing of emotionally durable design strategy.
Design: Jonna Haeggbloom, Photographer: Erik Cronberg.

Design for Longevity Emotional Durability

STRATEGY

If functional durability refers to whether a garment by its physical attributes will last, emotional durability refers to whether a user wants to keep and wear a piece. Today's use of clothing is mainly characterized by short-term wear and disposability, where garments generally are replaced due to the fact that a wearer have lost interest, rather than the pieces being broken. To design for emotional durability is about creating pieces that consumers wish to keep and use for longer, resulting in reduced consumption of new pieces and a stronger emotional connection with the pieces one already own. Factors that impact emotional durability are related to how a user feels when wearing a piece and are influenced by when, where and from whom the piece was acquired. Transparency of a garment's production will build on its narrative and strengthen the emotional connection as it reduces the distance between maker and wearer. Increased awareness will likely result in more responsible consumption patterns and a greater willingness to take care of one's clothing and as such improve sustainable behaviour in the use phase. Other factors influencing emotional durability is the comfort, fit and size, how well it emphasizes the users personality and how well it ages over time and use.

PRODUCT DETAILS



This coat created with a layered modular pattern technique fastened by fabric stripes. This technique gives the wearer the possibility to update and customize the piece by changing colours, materials and weaves of the fabric stripes as well as deciding whether the coat is long, short, sleeveless, with or without a collar.



Designing emotional durability into garments is complex, as what affects emotional connection, naturally, is different for every person and depends on one's own beliefs, memories and ideas. However, a few general guidelines that foster emotional durability:

- Enhance a garment's value and meaning by being transparent of its making and narrative
- Use co-creation and personalisation strategies to customize a garment's function and aesthetics to the actual needs and desires of the wearer
- Keep the interest of the wearer by using techniques for updating possibilities of the piece
- Use materials, coatings and techniques that age beautifully over time or that reveal patterns by use

MATERIAL PASSPORT



Easing the adoption of circular design strategies and the development of new solutions is an ongoing work for *circular:fashion*. Solutions are also developed according to specific brand environments or products. The whole life cycle of a garment and use scenario is kept in mind. According to the company's consulting framework, it is essential to match a circular strategy with products' functional needs, brand DNA and customer expectations. Hence, product ideas are combined with circular retail models and services. The company also educates designers by organising workshops and training on the issues mentioned above. Budde (29.01.2018) highlights four main categories to keep in mind when designing garments. These include material choice, material combinations, product construction and surface treatments. Furthermore, she shares her own notion of what clever design entails:

For me when I look at the product it gets just more beautiful if I see that I can disassemble all the different parts again and that I don't need to destroy it if I need a part of it. So for me it's just a notion of this is beautiful because I don't need to destroy it. It gives respect to every single part of this product.

Overcoming the lack of information and materials

As earlier stated, the lack of information and materials hinders textile product circularity (e.g. Hvass 2014; Elander & Ljungkvist 2016). Similar obstacles and required activities identified in case of *circular:fashion*, are described below based on three categories. These relate to attitude changes in fashion and supplier companies, as well as exchange about the constantly changing requirements.

Change in attitude

Based on *circular:fashion*'s experience with fiber manufacturers and textile sorters, the ideal textile products for fiber-to-fiber recycling would be those made of one single material, i.e. monomaterial products (Budde 23.01.2018), as opposed to the complex material blends and layered structures noted earlier (e.g. Franco 2017; Wedin et al. 2017). However,

challenges arise when thinking of surface design and details. Sourcing of buttons, zippers and other trims that fit certain materials may be difficult to find or are not yet developed in a recyclable way (Franco 2017; Budde 23.01.2018). Hence, there appears to be a clear gap between the requirements of textile recyclers and the current material offering. In addition, surface treatments like prints should be avoided in monomaterial design. These challenges ask for new replacing technologies but also positive attitude and creativity. Budde (23.01.2018) provides an example related to a project made for an urban tech-wear brand Acronym:

We decided to work with a monomaterial approach in the technical cycle and used a water-resistant membrane that can be regenerated with closed loop polyester recycling. One could assume this might be limiting or restrictive but for us it's much more a driver for innovation and creativity that led us to explore new closure methods or exciting technologies such as laser engraving to work with the material itself instead of adding any impurities like print colors.

Suppliers as Partners

A further challenge in sourcing relates to transparency. Similar to earlier findings (e.g. Elander & Ljungkvist 2016), *circular.fashion* has also found it difficult to obtain exact information about material content. Budde (29.01.2018) describes the current relationship with material suppliers as follows:

Some are really open and collaborative but some are ... First they need to understand the sense of why they need to make the effort.

But without transparency there is no way to assess the recyclability of the materials. This complicates the design process for circularity because many brands don't have their own research and development (R&D) team and are dependent on existing materials. Moreover, missing information is a further obstacle if brands want to make a full Life-Cycle Assessment (LCA) of their products. Doubts about sharing information

must be solved, which asks for trust between stakeholders but also new collaborative attitude. Budde (29.01.2018) gives an example of her own approach:

For me suppliers are rather partners than just simply suppliers because they need to know that they are kind of part of the system. Because otherwise they maybe don't understand why they should provide so much material information or why we want to check their materials so specifically. So they are partners as well.

A collaborative attitude builds close partnerships with suppliers, which is of great importance in reuse and recycling initiatives in fashion (Hvass 2016). Today, *circular.fashion* participates actively in the development of recyclable materials with a selection of certified suppliers within their network, which has resulted in new material innovations (Budde 23.01.2018), exemplified by a biodegradable polymer blended with natural fibers. This compostable material blend can be transformed into all kinds of soft and stable elements, such as textiles, buttons, zippers and even elastics. It implies that every part of the product can be made of the same molecular content and therefore the worn-out garment as a whole can safely enter the biological cycle (ibid.). A jacket designed for disassembly is another example which combines material and product level innovation. Budde (23.01.2018) clarifies this as follows:

The textile is designed to be disassembled into the two layers for separate cycles of composting and recycling. Additionally the sewing yarn is soluble so that the lining can be separated too. This innovation is a game-changing development and enables the benefits of stable synthetic materials combined with the flattering touch of natural fibers.

Participating in material development enables the company to easily access material information and set new requirements for textiles as other technologies advance. The work supports other fashion companies through the material database in the *Circular Design Software*.

Generally, fashion design teams in commercial companies approach material suppliers with sample references when sourcing new materials for upcoming collections. Newness is usually based on style, quality, comfort, functionality, etc. In design for circularity, however, the “new” indicates also the ability to fit materials to certain recycler, which requires changes in the dialogue and processes between fashion companies and suppliers. In the future, this may imply that fashion companies turn from pure customers to active co-developers, which might also extend the fashion designer’s role and require deeper knowledge of materials and their structures even at the fiber level.

Constant exchange with fiber manufacturers

As earlier mentioned, it is difficult to evaluate which materials could fit chemical fiber-to-fiber recycling due to gaps in material information (Elander & Ljungkvist 2016, Wedin et al. 2017). Developing new materials with suppliers, *circular.fashion* aims to overcome this challenge. However, it is no easier to access the information about the requirements for materials suitable for chemical recycling processes. First of all, each recycling process has its own specific requirements. Budde (29.01.2018) clarifies this with an example regarding the maximum amount of elastane that does not disturb the fiber-to-fiber recycling process:

I think it's now 2% with one recycler. But I think it's just valid for this one recycler, and there is another one who can not still handle it.

Secondly, everything is in the movement. Technologies advance so rapidly that it is hard to stay updated. This is good news in respect to the targets of CE but difficult for other stakeholders. As Budde notes (29.01.2018):

With one recycler, the cellulosic recycler, we are working already for ... I think 3 years now. And their process changed quite a lot. In the beginning we had very harsh requirements for textiles that could get into the process and now it's much easier. But sometimes you don't really find out with the first one.

When you maybe schedule a meeting again and you talk through another project and then by chance you realise that things have changed a little bit.

The way *circular.fashion* takes on the challenge of technological changes is now based on constant exchange with the fiber manufacturers. The company constantly pursue research into and analysis of the requirements of chemical fiber-to-fiber recycling processes. New materials with suppliers are further developed and matched according to those specifications and then evaluated. Materials on the *Circular Material Database* all fit current requirements. In order to share the information more efficiently in the future, Budde suggests the following (29.01.2018):

Maybe there is actually some easier way to get this information all the time. ... I mean we could implement it (information) on our platform so that they (fiber manufacturers) can post it. But I mean there are so many different companies, so why should they always give you the latest news. It's also hard for them to spread it through their network. But yes, I think the future vision would be to constantly update.

Until the requirements become more accurate and technologies develop further, monomaterial designs are favored by fiber manufacturers and should be taken into account also in design. However, material recyclability is not the only attribute to consider in circularity. Material selection should not only be weighted according to the preferences of fiber manufacturers, but instead the whole product life cycle including various use scenarios should be taken into account and matched with the material properties of each design. In terms of waste management hierarchy for instance, reusing should always precede recycling. Hence, product longevity (including good quality materials, adjustable fit, etc.) must be considered. Sometimes certain functionalities that further increase longevity may require material blends, maybe even elastane. Then a decision between the product longevity and recyclability may be needed until appropriate technologies are in place.

Increasing economical viability through *Circularfashion.ID*

Currently, there are very few garments in the market that meet the requirements of the textile recyclers (Budde 29.01.2018). Due to low volumes, textile sorters practically need to set up a room to collect garments separately until they have a volume that is worth sending to a fiber manufacturer (Budde 29.01.2018). Logistical challenges relate to the economical viability of the sorting process (Elander & Ljungkvist 2016). In the near future, however, *circular.fashion* aims to assess the viability of collecting and sorting by providing consumers with shipping vouchers so they can ship the old garments for free to a designated sorter within the *circular.fashion* network (ibid.). The effort should help evaluation of the overall quality of collected textiles.

Also, the lack of precise material information results in low volumes for chemical fiber-to-fiber recycling (e.g. Elander & Ljungkvist 2016). The *Sorting Guide* of the *circular.fashion* system provides a solution for this, enabling textile sorters to assess whether garments are suitable for second hand use. In addition, enables reliable material identification and designated recyclers through *Circularfashion.ID*. It also provides instructions to consumers on how to increase the useful life of products. Scanning the code with a smartphone permits easy access to the customer interface with a full history of the purchased product (Figure 3). Moreover, it allows fashion companies possibilities to increase the rate of customer retention.

Reliability of material identification is a key in building a reverse supply chain. Many different solutions are currently underway, but there is no point in companies developing systems that only match their own needs – as is the situation of today (Hvass 2014). As Budde (29.01.2018) notes:

No one is setting up a system like us at the moment, but as soon as someone does I think it would be just very useful to join forces because we don't need many different solutions. We need one solution that is used by many people.



circular.fashion

ALLISON



MYRKA
studios

ALLISON

MYRKA studios – Spring 2018
Size: One Size

The special plush look and the oversized fit transform jacket ALLISON into a real statement piece. It originated from a collaboration between Myrka Studios and circular.fashion and can be lead back into the closed circuit without losing any resources. The main material was a remnant textile and is made of 100% polyester. The silky lining, yarn and labels are made of recycled polyester from PET bottles. For each sold jacket the berlin based label donates 10€ to the «Clean Clothes Campaign Germany», which pleads for better working conditions along the production chain – so that in the future fair productions won't be the exception, but the norm.

Brand Material & Care Production Circularity Guide

Main Material



100% Polyester
#recyclable
Production Country: Germany
Recovered Overstock
[Learn more](#)

Lining



100% Rec. Polyester
#recyclable
Production Country: Turkey
Certificate (GRS)
[Learn more](#)

Yarn and Labels



100% Rec. Polyester
#recyclable
Production Country: Netherlands
[Learn more](#)

Care Instructions

Oberstoff/Main fabric: 100% Polyester
Futter/Lining: 100% recycled Polyester



Hergestellt in Deutschland
Made in Germany

Building an open source ecosystem

Moving towards CE means taking a systems perspective on fashion that includes all actors (Niinimäki 2017). Building a functional reverse supply chain that brings different stakeholders together has been one of the fundamental aims of *circular.fashion* consultancy. At the time of this case study, the company has managed to build a small ecosystem through which everyone within the circle is connected: the designer, user, retailer, sorter and recycler. Budde (29.01.2018) describes the starting point of building the multidisciplinary network as follows:

Timewise it would start with the recycling company. So, I started to map out where closed-loop recyclers are popping up, and which of those technologies are actually already in place or what could we work with. Because a lot of them are not really selling yarns yet or can't really take things back. So this was the first thing we researched. And then we looked for material suppliers that could potentially provide textiles that would fit the recyclers' requirements.

According to Budde (29.01.2018), the process has taken a lot of time in conferences and Skype calls. Having a specific project already in mind when contacting different actors has also been one crucial aspect in building the networks.

I was inviting these people to be part of the pilot project of building a circular collection and providing the information of how to close the loop for this collection. That was a very good basis to really have something specific to talk about. Like a real case.

Operating in such a manner has led to proof-of-concepts. One example is a collection 'Curated circularity – designed for Infinity' with a brand JAN'N JUNE (Figure 4), to whom *circular.fashion*, in co-operation with various other partners, managed to set up its own recycling system.

Figure 3. Customer Interface showing the full history of a garment. Jacket design by Allison, MYRKA studios.



Figure 4. 'Curated circularity – designed for Infinity' collection for JAN 'N JUNE. Photographer: Maximilian Probst.

Due to insufficient legislation, companies are left largely free to decide about their own sustainable practices (Hvass 2016). Hence, real-life cases are crucial for proliferation of sustainable practices, because they hold the potential to embody a proof-of-concept that can later encourage and motivate other stakeholders to take action. Ideally, companies also open their processes aiming for sustainability to other actors in the industry, as in the case of *circular.fashion*. Openness and sharing information are fundamental in order to further accelerate the transition towards CE. However, Hvass (2016) mentions a tendency of companies to develop sustainable solutions only for themselves. Yet, patenting has not (to the author's knowledge) been mentioned as a critical aspect in previous literature. Budde (29.01.2018) mentions patenting as a major concern potentially delaying material circularity. The following notion illustrates the approach of *circular.fashion* related to open source thinking:

I think this is really important because I think only with such an approach, being more open about it, can you actually accelerate this. Because if you

don't allow other people to use the same ideas then it's just one time in the world and then it will never make a change. I believe these ideas should be spread. And patenting in this area should be forbidden. And we should find other business models around it.

Spreading the word is at the heart of the company's business. Fighting for the same goal and being constantly in contact with different initiators is a daily practice. This can also be seen in the other activities of *circular.fashion*: 'Open Source Circular Economy days,' for instance, is one forum where the company has been active in promoting CE to consumers and other stakeholders.

Openness is also part of the membership strategy. Even though the online tool is currently based on a yearly subscription, a long term aim is to provide all the knowledge for free as soon as enough fashion companies join the platform. In this vision, the company would charge only for *circular.fashion.IDs*, meaning a price per product produced.

Future vision

Technology evolves at a pace that is sometimes hard to keep up with. Budde (29.01.2018) shares some of her own future visions that could influence designers' work crucially when aiming for textile circularity.

Obviously in the past blends of fibers were the most difficult. But I believe that in the near future we will be able to handle that as well. The main question will then be if we can handle both components of the blend and recycle both of them to virgin quality. We are aware that the separation of blends is currently possible, but I mean it's not happening at scale yet. Also, often the recyclers can just filter out one part, for example cellulose or polyester, if they don't know the exact composition of the blend. So what I think is that in the future we will be able to handle blends and additional at scale if we declare the exact composition accurately.

Designers will probably not have such a hard time in the future, Budde (29.01.2018) speculates. For instance, designers may not be obliged to make every closure part detachable when considering design for disassembly. Although, many of the problems within fiber separation could be solved, the information relating to full product content and the way garments are constructed will still be needed according to Budde (Ibid.):

Regardless if we can use it or not (blends), I think we need to be transparent about it and declare what the products contain. Because most recycling technologies simply work better if they know the content. And still I believe that some – let's say closure parts or blends – should not be used. And so I think there will always be some guidelines for designers about which materials should be used.

Despite possible technological advancements easing designers' work, fashion companies will need to create products according to many more purposes than selling garments, Budde states (23.01.2018):

When companies implement Product-Service-Systems to unlock the growth from material throughput, it will be the challenge of the designer to create the garments that are durable, versatile and modular so that the brand can actually max out the business potential of many use cases of one product.

Moving from products to services will also expand the designer's role. Budde sees designers becoming interdisciplinary translators between consumer demands, product functions (defined by the respective service offer) and requirements for material circularity (ibid.).

Products responding to those parameters become an inter-connective element that flows in circular ways between people in various relations. This way of thinking breaks up the whole idea of seeing a product as one product and a material as one material. Because a product is only one product in a certain setting with certain people but becomes a different product in another setting.

Discussion

When visualising the challenges of chemical fiber-to-fiber recycling (Figure 1), it becomes evident that change has to take place simultaneously throughout the value chain. Technological developments in automated textile sorting and chemical fiber-to-fiber recycling is rapid, which should effect the practices of other stakeholders. If we want to see chemical fiber-to-fiber recycling running at scale in the near future, the practices of designers and other stakeholders must change fast.

In order to set up a functional system, open dialogue is required in terms of the critical aspects mentioned earlier. More specifically, how each stakeholder could take these aspects into account in their own operations. How they deal with the upcoming concerns and possibilities will vary based on companies' own interests as long as the common guidelines are initiated and new legislation commences to oblige industry practitioners. Actors that could facilitate the discussion between stakeholder groups are needed. *Circular.fashion* is already one of the visionaries achieving this and may have the ability to accelerate the change with its exemplary and committed activities.

This study has pictured the state-of-the-art situation at the turn of the year 2017–2018, and for this reason may only hold value for a limited period of time. Further weakness in the study is the focus only on one specific case. The issues reported may only be relevant for the case in question. *Circular.fashion* is a relatively new consultancy and actor within the field of sustainable design. Hence, it remains to be seen how the *Circular Fashion System* will eventually work out. However, the case brings forth many crucial aspects entailed in operating with all stakeholder groups within the circular textile value chain. It provides valuable information for fashion companies on ways to reimagine the role of designers and the organisation of design practices. As such, it provides an excellent reflection point for further studies on challenges and the latest innovations in circular fashion, but also a case by which to compare changes in practices and industry operations more generally.

Based on this study, several future research directions are suggested. Regarding textile volumes and planning the reverse supply chains, research is needed concerning the estimated flows of the newly designed pieces that fit chemical recycling. A further difficulty remains as to how to share the newest information and developments between stakeholders in the circular textile value chain and how to facilitate dialogue between them. In addition, studies on different solutions and proof-of-concepts are constantly needed to spread the information on best practices to each stakeholder group.

Conclusions

This case study was conducted to research the evident changes in fashion design practice when moving from a linear to a circular economy. Because of its novel approach, *circular.fashion* consultancy was used as a descriptive case to illustrate how to design clothes that at the end-of-life could be circulated into new fibers. Challenges in the circular textile value chain, as identified in the previous literature, provided the basis for reflection when studying the practices of *circular.fashion*. The description of the company's activities revealed many practical solutions and strategies in accordance with each challenge. Solutions depict the changing landscape of fashion designers' daily work, as summarised below:

- Material choice, material combinations, product construction and surface treatments are the most important factors designers have to consider when designing for circularity.
- Online tools such as the *Circular Fashion System* hold potential in educating designers on the subject and easing their work under pressure of time and price.
- A change in attitude is required on many levels:
 - Innovation exists in the challenges, meaning that designers should expand their creativity beyond the contemporary practices.

- Being dependent on the existing materials (not suitable for recycling) can be overcome by partnering with suppliers.
- Due to rapid technological advances, fashion companies need to prepare themselves for constant exchange with textile sorters and fiber manufacturers.
- Economical viability of collecting and sorting textiles requires changes in design practices, which touch upon the choices of materials, structures and surface designs. These have to be aligned with the requirements of recyclers.
- A reliable identification system like *Circularfashion.ID* can ease the sorting process but requires volumes and multiple companies utilising the same coding system.
- In order to accelerate the change, more real life cases are needed.
- Best practices should be shared openly. Patenting may hinder the change and hence should be weighted thoroughly.

In the case of *circular.fashion*, the designer role extends from design to materials, and finally to recycling processes. Even though material knowledge is part of basic fashion design competence, in *design for circularity*, deeper understanding of material and fiber structures may be required – as well as knowledge of chemical processes or at least the basic idea of their possibilities in fiber-to-fiber recycling. This enables designers to expand their skill set from product design to innovative material *development*. In *circular.fashion*, the designer works also as a coordinator and translator between different fields. In individual company cases, the work requires matching between various aspects: user demands, product functionalities, requirements, strategies, materials, brand identity, etc. In this equation, a fashion designer becomes a matchmaker who plays the key role in textile circularity.

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Design Strategies

06

Sustainable Design Cards: A Learning Tool for Supporting Sustainable Design Strategies

Ulla Ræbild, Karen Marie Hasling

The Sustainable Design Cards is a practice-oriented tool for designers and design educators working with product longevity and circular thinking. This chapter describes how and the context in which the cards were developed. The chapter contains an introduction of the cards by describing the structure and content of the individual card as well as of the deck. Then the use of the cards is illustrated through two case studies, and finally there is a reflection on the observed uses of the deck.

Keywords: Strategic design tools, sustainable approaches, circular thinking, product longevity, design education



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Introduction

The Sustainable Design Cards have been developed as a learning tool to inspire designers and additional actors in and relating to design to work with strategic approaches to sustainable development focusing on product longevity. The cards consist of a physical deck of 28 cards and a supporting digital platform with additional instructions and cases.

The cards have been developed with a dual focus; an educational and a corporate focus in order to reach existing real life challenges and future potentials.

The concept of sustainability is both far-reaching and complex. The cards focus on clarifying different ways in which design can support sustainable development or sustainable thinking.

The cards can be used to:

- Guide, inspire and create awareness towards sustainability in design processes
- Frame and concretize processes and strategies for sustainable thinking
- Communicate knowledge and values to external stakeholders
- Create shared understanding in cross-disciplinary teams
- Reflect on and re-examine existing processes or strategies to identify new opportunities.

Background

Design for longevity and ways to work with sustainability in design practice

In order to achieve a proper theoretical basis for the topic of the cards, which is design for longevity, it seemed relevant to unfold the concept of product lifetime with inspiration in Mestre and Cooper's (2017) A multiple lifecycle approach to circular design and Cooper's previous work on product life spans, slowing down consumption and preventing obsolescence (2010; 2005; 2004) as well as Bakker et al.'s circular business

perspective (2014). This links to publications on circular business models from the Ellen MacArthur Foundation (2013; 2012), and how product lifetime relates to product service and systems thinking as discussed by e.g. Ceschin (2013) and Vezzoli et al. (2014). To further emphasize the relation to sustainable design, the work draws on a design for sustainability framework proposed by Ceschin and Gaziulusoy that offers a mapping of ways in which sustainability is perceived and approached (2016). These ways are characterized by an increased understanding of the many complex and interacting issues that must be taken into consideration, in order to obtain a real and lasting impact (ibid. 144) and is in line with former and present developments within this domain as discussed by e.g. Bhamra and Lofthouse (2007), Lilley (2009), Keitsch (2015) and Manzini (2015).

The relevance of the card format relies on knowledge on methods use in design practice and education as discussed by e.g. Badke-Schaub et al. (2011), Roozenburg and Eekels (1995) and van Boeijen et al. (2013), and on the practice of using cards in the context of design processes in and with organisations (IDEO 2003) and in education (Friis 2016). Furthermore, we have developed the cards as ‘game pieces’ (tangible learning material) that have been shown to speed up the process and create common ground when working in teams (Hornecker 2014).

Developing the cards

The Sustainable Design Cards have been developed and matured in two iterations.

The first iteration took its starting point in a research project conducted between raw fur supplier and auction house Copenhagen Fur and Design School Kolding (DSKD) focusing on perspectives of sustainability within the company from a design perspective (Skjold et al. 2016). The project was completed between August 2014 and March 2016 and comprised four different research perspectives on fur and sustainability: cultural heritage, material processes, design approaches and user practices.



The first prototype of the deck was developed in a consecutive development project with the company (August to November 2016), where two fashion designers were employed to develop designs from design briefs centred on product longevity. Here the deck of cards was developed to enhance understandings of sustainability through dialogues with and observations of the designers. Further reading on this process can be found in Hasling and Ræbild (2017).

The second iteration, from January to September 2017, looked into teaching approaches to sustainability at Design School Kolding in order to develop learning tools helping students to navigate in a future sustainable landscape. The project focused on ensuring coherence between design and sustainable business models and was funded by The Danish Foundation for Entrepreneurship. Here the cards were re-evaluated and reformulated to target all students within the institution covering fashion, textiles, industrial, accessories and communications design.

In addition to the physical deck of cards, a supplementary digital platform was developed (www.sustainabledesigncards.dk). Besides the information on the physical cards, the digital platform provides company examples that show how the cards have been used by various companies and design students. All of the cards are available for download in pdf format.

By having a dual focus on the design of the cards, one from a corporate and one from an educational perspective, the cards have shown to be applicable and helpful to a broad span of actors with varying experience, disciplinary backgrounds and competences.

Figure 1. Developing the deck of cards with feedback from designers (photo by Karen Marie Hasling).



Figure 2. Final deck of cards (photo by Liv Johanne Eskholm).

The deck of cards

The final deck comprises 28 cards in A6 format. The cards provide information on various sustainable design approaches such as ‘Customisation’, ‘Environmentally Friendly Materials’, ‘Labelling’, ‘Multi-Functionality’ and ‘User-Understanding’. The complete list of cards can be found at the end of the text.

One side of the cards communicates visually, through symbols, while the other side contains written information on the particular approach.

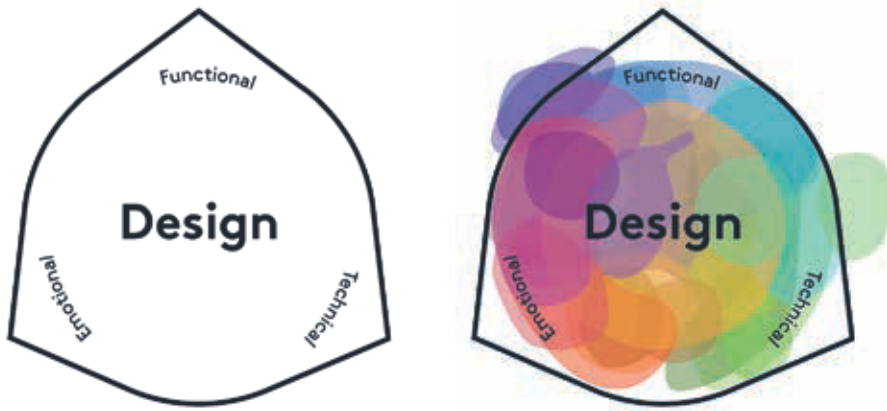


Figure 3. The Design for Longevity Compass.
Left: Compass base, right: compass with all
approaches (figures by Karen Marie Hasling).

The visual side is dominated by a visual compass model, ‘the longevity compass’ (Figure 3) that divides longevity into three different approaches to the concept of ‘lifetime’ within design for longevity. These are ‘technical lifetime’, ‘functional lifetime’ and ‘emotional lifetime’, where ‘lifetime’ refers to the extent of efficient or sufficient use in a product (Cooper 2005) and is often measured in length of time.

The fact side presents information on the specific approach, including descriptions of **what** the approach is about, **why** it is useful, particular challenges, real life **case examples**, **links** to other approaches and **further reading**. A card example is shown in Figure 4.

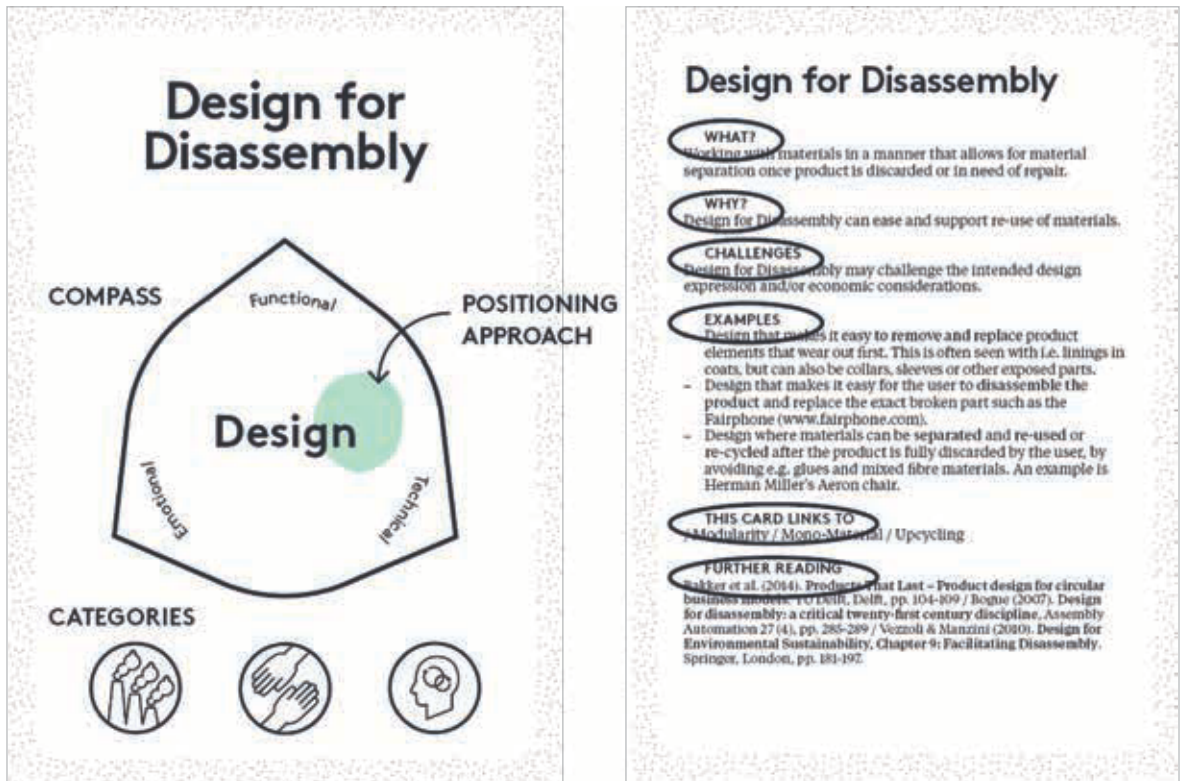


Figure 4. An example of a card for the approach 'Design for Disassembly' with a graphics side (left) and an information side (right) (figures by Ulla Ræbild & Karen Marie Hasling).

Description of lifetimes

- **Technical lifetime** refers to the length of time a product stays in use before it breaks or wears out and often relates to the materials the product is made of. This can for example be when a zipper breaks or a pocket gets a hole. The technical lifetime of textile materials is described in for example Hatch and Gohl and Vilensky's works on textiles science (Gohl and Vilensky 1984; Hatch 1993).
- **Functional lifetime** refers to the length of time a product stays in use before its functionality no longer meets the user's expectations or needs and often relates to the physical design of the product. This can for example be a dress that no longer fits due to changing body size or a jacket that becomes too warm or cold due changing seasons or geographical place of living. In fashion and textiles, functional lifetime has been discussed by Clark (2008), Gwilt (2015) and Niinimäki (2013), among others.
- **Emotional lifetime** refers to the length of time a product stays in use before the user stops having emotional attachments to it. This can for example be a jacket inherited from a grandparent or a garment bought on a holiday as a personal souvenir. In the context of fashion and textiles, emotional lifetime is discussed by, for example, Chapman (2005) and Fletcher (2016).

Each approach is positioned in the compass as a cloud space, as each can be approached in multiple ways depending on the intention. Furthermore, the cloud spaces have been colour-coded in accordance with their orientation in the compass. Consequently, approaches that are oriented towards 'technical lifetime' have a blue hue, approaches that are oriented towards 'physical lifetime' have a green hue, and approaches that are oriented towards 'emotional lifetime' have a red hue. Finally, the position of cloud spaces considers the degree of control in the concept development and design process; thus, cloud spaces close to the centre can be strongly controlled, while cloud spaces that are positioned in the periphery of the compass can be less controlled and are controlled by outside actors and factors.

In combination with the longevity compass, six categories that work across the product lifecycle can also be used as a way to navigate between the cards (see Figure 5). The categories are 'Material', 'Production', 'Transport and Retail', 'User and Practice', 'Recovery' and 'Design and Concept'. Each card displays between one and four categories represented by visual icons under the longevity compass.

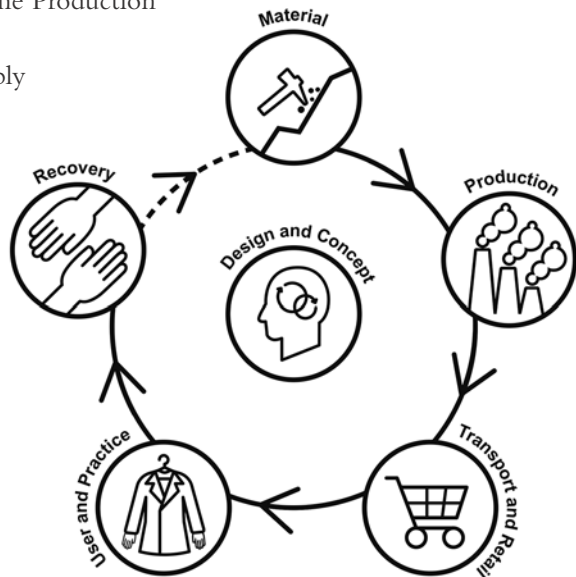
Material relates to aspects concerning raw materials procurement, such as mining minerals, extracting crude oil, breeding animals and growing crops, but also how to handle materials in the entire product lifecycle. Examples of cards in the Material category are:

- Environmentally Friendly Materials
- Mono-Material
- Technical Durability

Production concerns aspects within production and processes that add value to raw materials and apply them in components, part or end products. The category is related to ways in which products are produced and manufactured.

Examples of cards in the Production category are:

- Design for Disassembly
- Local Production
- Zero-Waste



Transport and Retail relate to aspects that concern logistics and handling in products' journey from materials procurement, to production, to retail and sales and to recovery or recycling of materials or products. Examples of cards in the Transport and Retail category are:

- E-Shop
- Ethical Supply Chain
- Production on Demand

User and Practice concern products' use phase and thus how products are used and worn, and how, while in use, users can relate to products. Examples of cards in the User and Practice category are:

- Co-Creation
- Re-Use
- Repair

Recovery relates to aspects that deal with what happens to materials and products after use or in-between lifecycles and how a product lifespan can be prolonged through this.

Examples of cards in the Recovery category are:

- Formal Alteration and Modification
- Mono-Material
- Rental Service

Design and Concept relate to aspects in which the designer can 'program' prolonged lifetime through ways of working with concepts.

Examples of cards in the Design and Concept category are:

- Embedded Storytelling
- Modularity
- Multi-Functionality

Figure 5. The six Design for Longevity categories: Material, Production, Transport and Retail, User and Practice, Recovery, and Design and Concept in relation to a product lifecycle (figure by Karen Marie Hasling).

User experiences with the deck of cards

During autumn 2017, the deck was distributed to designers and researchers internationally, mainly by word of mouth and by request. Due to funding, it was possible to make the first batch free and also hand out cards to colleagues and students at DSKD, who in this period engaged in sustainability projects. Two of those DSKD projects have been included here as cases to further the understanding of how the cards might aid sustainable design development. Nine case participants within four user perspectives have been interviewed, as illustrated in Figure 6.

The first case was a six-week shoe design course developed with Danish shoe brand ECCO. The project was interdisciplinary, meaning the students worked in mixed groups of four to five people with backgrounds in fashion, textile, accessory and industrial design. Based on a design brief, each group developed a concept and three prototyped shoes. This year the brief included a demand for a sustainable strategy.

The case study includes two participants to represent the instructors a) the overall ECCO project leader and head of textiles, and b) the external Belgian shoe designer who took part in supervising the groups. Representing the learners are four first semester master students, who worked together in a group.

The second case was a one-day workshop organised by Sustainable Prosperity (SP). SP is an EU funded collaboration between the design cluster Design to innovate – D2i, Southern Denmark Region and DSKD. Within SP small to medium sized companies in the Danish fashion and textile sector work with sustainability and innovation in workshops facilitated by consultant designers. Here a total of 30 companies have worked for 5 months each on improving business models in order to strengthening their sustainability performance.

The case study includes a workshop facilitator from the project to represent the instructors. Representing the learners are a workshop participant, who has a company that develops baby equipment such as

	Instructor	Learner
Education		
Industry		



Figure 6. Overview of the natures of the four perspectives discussed through the cases; in relation to the context being ‘education’ versus ‘industry’ and the role of the participants being ‘instructor’ or ‘learner’ (photo by Liv Johanne Eskholm).

baby carrier sleeping bags. The workshop participants used the cards to map out current and future sustainability activities and strategies on a company timeline.

Semi-structured interviews (Kvale and Brinkman 2008) have been conducted of approximately 20–30 minutes each. The interview guide centred on when and how the cards were used, as well as possible strengths and weaknesses of the deck. None of the participants received any introduction to the cards prior to their use. All of the participants were interviewed after their experiences with the cards.

In the tables below, interview excerpts are organised in emerging themes. The tables are categorized in themes: *collaboration*, *process*, *communication*, *understandings* and *challenges* for the educational context (Table 1) and the industrial context (Table 2). The utterances have been condensed for readability purposes and are followed by reflections on the outcome below.

Table 1. Experiences of use of cards in the educational context.

	INSTRUCTORS	LEARNERS
COLLABORATION	The cards have enabled the students to negotiate and identify what they want to focus on in relation to sustainability. Sustainability is complex, because all categories in the lifecycle are interlinked. However, the students have used the cards to identify their take.	In the beginning, the students were thinking very differently and the cards have provided a common ground. First the students identified relevant cards individually and then used these to negotiate project focus in the group.
PROCESS	Instead of starting from a problem, the students started with the cards and used them to identify the most important idea that they wanted to apply to the project. The cards helped the students to plan, strategize and investigate a sustainable take on the project. In the process, they gained new insights on the complete product lifecycle. The cards helped the teachers, to keep the students focused on their chosen sustainable approach throughout the process.	Students have used the cards to iteratively reflect on their idea in terms of knowledge building, research strands and design potentials. Students have used the cards like a go to encyclopaedia i.e. an accessible and available source on sustainable strategies, where they did not have to read through extensive texts first.
COMMUNICATION	The students used the cards before the final presentation to reflect on their process, core themes and main achievements in the project.	The cards were used in visual presentations for internal and external stakeholders. Students found that the cards can be useful for raising awareness on sustainability among people that are not designers.

UNDERSTANDING	The teachers found that some groups chose several approaches that they found to be important and made their own product life cycle using the cards. It is an important part within an approach, that students consider and take care people.	Students express that they like the way the cards exemplify the approaches in the information and the real design and brand examples. Some of the students said, that they would like to use the cards outside the context of the school, for example if they work as freelancers, as a way of checking for sustainable strategies and potentials.
CHALLENGES	When students chose an approach, they had to be aware of what is needed in the design to achieve this approach. This could be difficult for the students because the overall subject, here shoe design, was new to them. In the future, the teacher will present the card lifecycle and categories next to a shoe specific product lifecycle, and look for similarities and differences, as a shoe life cycle is more complex. Students did not use the compass much, but that might be because the cards were new to the teacher too. Next time, the teacher will try to work more with the cards and explain to students how to go more into depth with the information. Teachers found that it might be relevant to have a deck that is an extended version on materials, also for companies.	Students found that you have to be used to using methods, to understand that it is a tool and not a guideline. That you don't HAVE to do it like it says on the cards, but it is intended to help you in whatever way it can, in relation to your project or in a co-working situation. For some students, there were too many cards. They found the individual cards easy to work with, but all the other cards could be a distraction. Other students found that it was both positive and negative that there were many cards. It can be hard to choose, but it also provides choices and allow narrowing down number of approaches in the process. To begin with, students had to spend some time investigating the deck, to understand all the colours and symbols. They admittedly didn't read the information folder.

Table 2. Experiences of use of cards in industry context.

	INSTRUCTOR	LEARNER
COLLABORATION	Two small companies participated in the workshop. First, they worked individually with the cards and then they sparred with and presented their work to each other.	—
PROCESS	The instructor highlighted that the cards were used to identify already existing initiatives within the companies. The instructor noticed that learners lay out the card in relation to 'how they relate to each other' and 'how they relate to us'; thereafter they were grouped in 'this we do' and 'this we do not do'. The instructor wants to continue to use the lifecycle model, but with addressing the question 'what might be?'	The learner related the cards to the persona they were asked to develop in the workshop by asking 'how can we apply these cards to the persona and to the things we imagine will happen to the future persona?' The learner elaborated on, what they as a company have resources to do. Here the cards were helpful to discuss different approaches, for example 'how they could disassemble the product after use and re-cycle it?'
COMMUNICATION	According to the instructor, it can be overwhelming for participants to get acquainted with all the cards. Therefore, the instructor made an index for all the terms and approaches that was introduced in the beginning of the workshop. For a next time, the instructor would like to make a better introduction to the cards including case examples. This would make it easier to understand that there are different levels of how well the cases perform in terms of sustainability.	The learner spent a lot of energy asking themselves what each individual card was about so it could be communicated with their Chinese supplier and Bulgarian manufacturer. According to the learner, specifically one of the cards appealed to a more open and communicative approach on how to share their message with the consumer. They acknowledge that they have to include the consumer more in the process.
UNDERSTANDING	The instructor already uses a number of models and for this workshop it was found interesting to test the cards because they fitted into an existing model representing circular economy.	For the learner and her colleagues, the examples on the cards were used a lot to understand, how the cards can be used.

	The instructor noticed that participants read the cards closely and took a long time doing so. They went through every card and talked about what it could mean. According to the instructor, companies find 'Mono-Material' hard to understand; especially within a textile context, because it requires to look at the fiber level and not only at the object itself.	If you, as a company wish to work with something sustainable and understand how your company fits into these things, the cards were really relevant and helpful, as they provide a summary of thoughts and expressions in a holistic way. For many aspects, the learner's company would not be able to fit in with the cards, but there were also a lot of things, where the cards matched with their direction. The importance of these (in a sustainable context) was not something the learner was aware of before working with the cards. To this she noticed, that one approach had been offered by the learner's manufacturer for the last year and during the workshop she thought: 'Why not catch the ball now?'
CHALLENGES	The instructor emphasized that the cards should initiate own reflections among those using them, by means of <i>what do we know?, what have we heard?, what do we find interesting? Or makes us wonder?</i> It was difficult for the learners, most likely because many terms were new to them. The instructor hoped to lift the participants' knowledge on circular economy, which didn't happen in the given workshop. She argued, that the cards should be used as the frame for a complete line of workshops, with the value chain as a key. The instructor commented on the fact that the names of the category icons only appear in the folder and not on the individual cards. However, this would help to remind the users to remember and recognise the categories.	The biggest challenge for the learner was the English terms. Even though she's used to communicating with foreign suppliers, these terms were completely different. It was hard to remember everything even after having been through all the cards and during the workshop is was necessary to reassess the cards and discuss in which contexts they could be used. The learner was not sure if she would've been able to figure out how to work with the cards by herself. Nevertheless, she acknowledges that there is not real right or wrong way, but propose adding some explained examples of how the cards can be used.

Reflection on use practices

When looking at the experiences, similarities and differences in the users' application and understanding of the deck emerge. The difference in length and set-up of the use contexts apart, it can overall be established that the four user types have found the cards helpful in addressing and working with sustainability. However, the way that they have worked with the cards, and the challenges they have encountered in doing so, seem to differ depending on the task. The reflections are summarized in the following sections.

Descriptive and prescriptive use modes

Firstly, the interviews show a divide between the two types of learning challenges: to develop a novel design concept in a design educational context versus to develop sustainable strategies in an existing company. The design students work from a clean slate, and use the cards within the group to identify and negotiate sustainability approaches that can suit their common interests and conceptual sub-theme. Then they develop a circular business model strategy, and use the cards again later in the project to evaluate the outcome. The company participants, on the other hand, use the cards firstly to evaluate and understand their existing practice, in terms of sustainable potentials, and then to plan future strategic developments. So, there seems to be two kinds of modes, depending on whether you are developing something from scratch, or you are in the process of transition. For both types of learners, a core exercise seems to have been to narrow down the number of cards applied through an iterative editing process. This has been done in order to focus the development and get a clear understanding of where in the product lifecycle the main effort is to be made and then build a circular strategy from this point.

Novel versus trained user

Another divide can be identified between novel and trained users in terms of working with design methods and design cards. Generally, it seems to have been more challenging for the external users, than for the DSKD users to apply and understand the cards as a tool. The same can be said about the sustainability terminology used on the cards, where especially the companies experience a rather steep learning curve, but then they also had a lot less time. The challenges show, that as an instructor it is worth considering the 'baggage' that both you and the learners bring in terms of level of prior experiences or education. It can also point towards further development of the associated webpage to provide novel users with guidelines.

Barriers versus creative constraints

Acknowledging the experiences obtained in the interviews, bearing in mind that it is a very small sample group, the instructors overall find that the deck raises the learners' awareness of how to address sustainability through design. Moreover, that the deck forces a holistic and circular perspective, as any given choice in approach links to consequences. Instructors also depict a process whereby learners slowly embed the cards in practise – e.g. the up-cycling card was sunk into the up-cycling shoe concept and final design; the design for disassembly card was sunk into the company timeline and future strategy. Hence, sustainability, when addressed through the deck, becomes a creative constraint that inspires new thinking and doing. The feedback from ECCO, for example, was that the projects, in the course described in this study, represented the best outcome yet, in terms of creativity and research depths. This is an important insight, as sustainability is often perceived as a barrier by students – as something that will somehow limit their creativity rather than enhance it.

Teaching tool

Challenges expressed in terms of using the deck as a teaching tool relates to the many types of information on the cards, which takes a while to understand. It was also pointed out, that in order to use the deck, one needs to have a strong understanding of the subject that one is applying it to, or any development is jeopardised by superficiality. This might not always be possible in educational contexts as the cards are likely to be applied to subject areas that are new to students. The instructors further point to a challenge: When you work with design and sustainability, you encounter many different conceptual models and maybe you have even developed your own. So how does the models and information on the cards align with what you, as a teacher, wish to present?

Accessibility

Learners generally express a positive impact. For example, that the cards provide overview and insights without having to read through masses of literature; that they raise awareness of what you already do and how this can be further developed. That they provide industry context, and enable internal and external communication. The fact that the deck was free, is stressed as a strong plus. The company participants suggest for the deck to be given to all start-ups, so that a circular strategy is considered from the beginning. All express that they would have liked an introduction to content and use up front. Nevertheless, all participants express new understandings of how to work with sustainability and product lifetime in a circular perspective.

Further developments

Based on this small-scale case study, the cards seem to show potential in terms of aiding sustainable development through circular strategies for practice and education. Some interviewees mentioned that perhaps more in-depth and specialised decks could be developed, e.g. on materials, or design for social sustainability. It is also suggested to include

an index of the cards. Industry requested best case examples on the webpage that show how companies have made the transition in business strategy from linear to circular.

In closing, the authors of this chapter hope that *the Sustainable Design Cards* can nurture the belief, that *diffusion* of awareness is as relevant a strategy as the often mentioned up-scaling of production when the goal is to further sustainability and its impact on the world.

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Overview of cards

Aesthetic Lifetime	Ethical Supply Chain	Local Production	Re-Use
Co-Creation	Formal Alteration and Modification	Maintenance	Rental Service
Customisation	Formal Sharing and Heritage	Modularity	Repair
Design for Disassembly	Informal Alteration and Modification	Mono-Material	Technical Durability
E-Shop	Informal Sharing and Heritage	Multi-Functionality	Up-Cycling
Embedded Storytelling	Information	Product History	User Understanding
Environmentally Friendly Materials	Labelling	Production on Demand	Zero-Waste

Business Thinking

07

Slowing Resource Loops in the Clothing Industry through Circular Business Model Experimentation

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The fashion industry is characterised by downward pressures on prices, fast consumption, and a high ‘disposability factor’, where textiles and clothing have become consumables rather than durables. Circular economy, focused on slowing, closing and narrowing resource loops provides a promising approach to tackle these issues. This chapter explores how a large retailer can incorporate the more challenging strategies of the circular economy, those focused on slowing resource loops, in their business model. The chapter provides an in-depth case study of a large international clothing retailer embarking on a journey of circular business model experimentation. An iterative process is presented as well as opportunities and barriers associated with slow consumption business models as part of the business model experimentation process. Based on this, suggestions for researchers, policy makers and practitioners are made to address slow consumption as part of business models.

Keywords: Slow consumption, circular economy, business model experiment, sustainable business model, circular business model, clothing retailing



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Background

Sustainability has become a major issue in the fashion industry. While there is downward pressure on prices and increasing competition, there is a growing concern about social and environmental issues (Miller 2016; Bocken et al. 2018). Unsustainable levels of clothing consumption and associated disposal patterns are driving demand exacerbating the issues in the industry (Niinimäki & Hassi 2011). It is estimated that in the past 15 years clothing production has doubled, driven by a growing middle-class and increased per capita consumption in mature economies (EMF 2017). This is linked to the fast fashion phenomenon, characterised by quicker turnarounds of collections and styles per year, lower prices and a disposable nature of fashion: it has been estimated that half of fast fashion produced is disposed of within a year (EMF 2017). If the current trajectory continues going forward, the clothing industry will account for using 300 million tonnes of non-renewable resources by 2050, triple the amount of the 98 million tonnes in 2015 (EMF 2017).

The circular economy may be viewed as a potential paradigm to combat sustainability challenges (Blomsma & Brennan 2017; Geissdoerfer et al. 2017; Ghisselini et al. 2016). While the circular economy paradigm has been criticised for emphasizing the ‘easier’ corporate environmental strategies such as recycling (Allwood 2014), the discourse is shifting towards including strategies of slowing resource loops and tackling unsustainable consumption patterns (Bocken et al. 2016a). However, in reality business practice is behind and the concept is still in its infancy (Blomsma & Brennan 2017). The ‘radical’ forms of circular business model innovation, such as those associated with slowing resource loops and consumption (e.g. sharing, Product-Service-Systems) and remanufacturing models are still relatively low on the corporate agenda to date, based on a content analysis of corporate reports of S&P 500 firms (Bocken et al. 2017).

The linear economy is characterised by taking (materials, energy), making (production) and disposing products after a limited number of

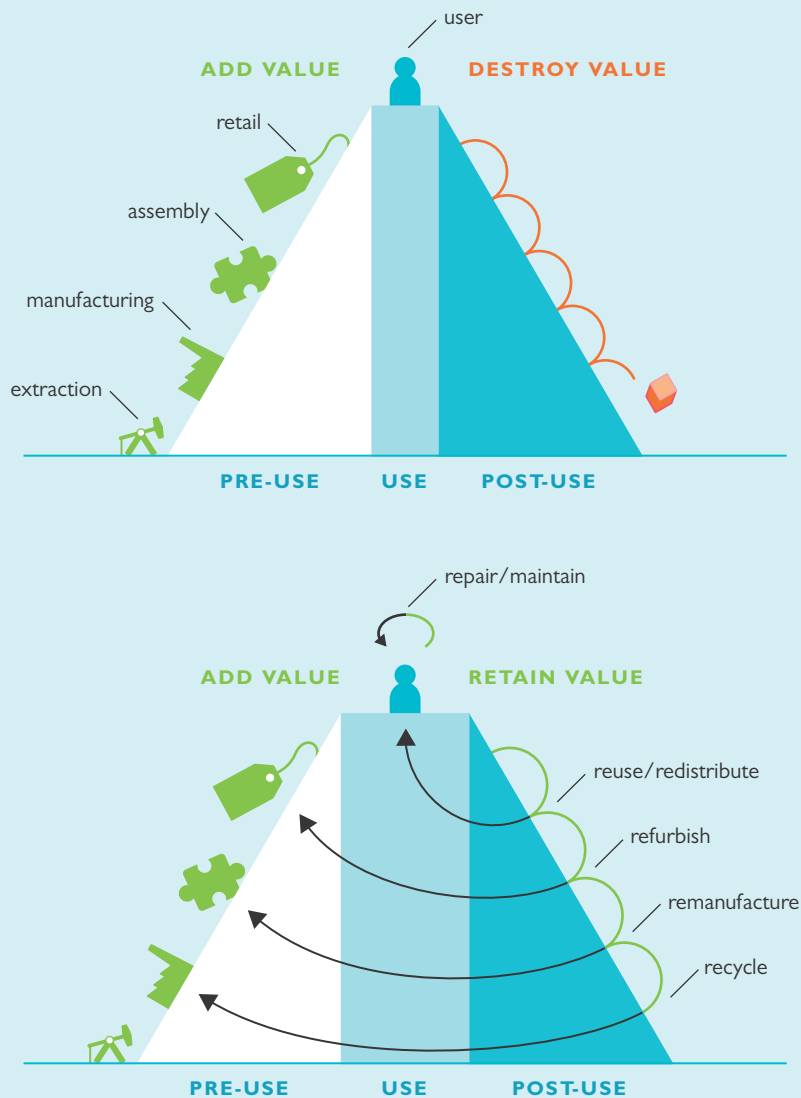


Figure 1. From destroying value in a linear economy to retaining value in a circular economy (Achterberg et al. 2016).

uses (Bocken et al. 2016a; EMF 2017). In contrast, the circular economy can be defined as a “regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling” (Geissdoerfer et al. 2017, 759). At the same time, other reviews of circular economy literature have highlighted the necessity of not neglecting the social dimension (Blomsma & Brennan 2017; Murray et al. 2015). It is argued that “what aids or inhibits socioinstitutional change in waste and resource management can be enriched by paying attention to how material flows are shaped by, and interact with, nonmaterial flows, that is, the different forms of social embeddedness.” (Blomsma & Brennan 2017, 611).

The current textiles system can be described as predominantly linear: non-renewable resources are extracted to produce that are often used just once or twice after which the materials are landfilled or incinerated (EMF 2017, 3). Clothing represents over 60% of the total textiles used (EMF 2017). The Ellen MacArthur Foundation estimates that USD 500bn of value is lost every year due to ‘clothing underutilisation and the lack of recycling’ (EMF 2017). In contrast, in a future circular economy, materials such as textiles should be maintained at the highest level as long as possible through strategies such as maintenance and repair, service and warranties as well as reuse over time (Achterberg et al. 2016). Currently, material, environmental and economic value are destroyed rather than maintained (Figure 1). This linear take-make-dispose model has numerous negative environmental and societal impacts related to greenhouse gases, water use, toxic emissions, and landfilling, and associated health, safety, and wellbeing impacts (EMF 2017). Hence, new ways of doing business are urgently needed.

Circular business model innovation may be viewed as a systemic way to tackle the take-make-dispose paradigm. Business models include a value proposition (product-service offering to the customer and wider society), value creation and delivery (what value is created and how) and value captured (the way in which money and other forms of value

are captured) (Richardson 2008; Teece 2010; Bocken & Short 2016). Sustainable business models are about creating positive value for the environment and society, in addition to the customer; they integrate a multiple-stakeholder perspective in the way business is done, and specifically include environmental and societal parameters into the business purpose and metrics in addition to economic concerns (Stubbs & Cocklin 2008). As an example of a sustainable business model, circular business models emphasise environmental aspects and in particular how to shift away from a take-make-dispose paradigm to narrowing (efficiencies), closing (recycling) and slowing (reuse, slow consumption, remanufacturing) loops (Bocken et al. 2016a; Geissdoerfer et al. 2017).

To tackle the impending sustainability crisis, firms urgently need to innovate new business models. However to switch from a known model to an alternative one is risk laden (Chesbrough 2010; Teece 2010). As a result there is a need to trial new ways of doing business. Business experimentation is seen as a way to remain competitive in the long-term (Chesbrough 2010), while tackling key sustainability issues and the transition to a circular economy specifically (Kraaijenhagen et al. 2016; Weissbrod & Bocken 2017).

Business experimentation is a potential key avenue for accelerating change for sustainability by exploring diverse possibilities around how a business could create value, or understand what works in which particular situations in a real-life business context to address key sustainability challenges (Bocken et al. 2016b, Weissbrod & Bocken 2017). In contrast to pilots, experiments are fast, small scale and low cost (Ries 2011; Osterwalder et al. 2014). While popular with startups, 'large businesses can also find inspiration in business experimentation to develop sustainable business models and accelerate positive change for sustainability' (Bocken et al. 2016b). Examples of experimentation practices include co-creation sessions, focus groups, Facebook A/ B tests (comparing the viability of two campaigns), and rapid service prototyping (e.g. digital prototyping through creating web landing pages or physical prototyping through creating low fidelity, e.g. simple paper versions) (Schuit et al. 2017).

This book chapter explores the case of a large international clothing retailer who has embarked on a journey of circular business model experimentation. It reports on the approach taken and overall findings obtained regarding slow consumption initiatives as an example.

Case study approach

The case study covers a 2.5-year collaborative research project (August 2014–November 2016) part funded by Innovate UK, between the University of Cambridge and an established international clothing retailer. The aim for the retailer was to eliminate clothing waste being disposed in landfill, using a circular business model approach. The project was about identifying pathways to transform the current linear business model to a more circular one, through business model and supply chain innovation facilitating recovery and reuse of clothing, using experiments.

Slowing resource loops – a focus on waste prevention in the first place by encouraging clothing reuse – was the emphasis of the project. A secondary objective was to learn from this new approach and develop a circular business model experimentation capability. In the project,

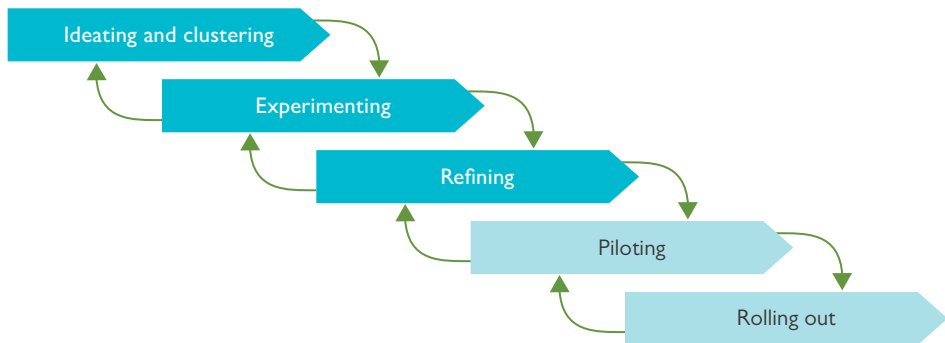


Figure 2. Iterative process of circular business model experimentation. Developed from Osterwalder et al. (2014) and Bocken et al. (2018).

experimentation was undertaken, building on Lean Startup techniques (Ries 2011; Blank 2013), characterised by rapid learning iterations in a low cost and resource manner (Ries 2011; 2017). While developed for startups, the Lean Startup approach could also apply to large businesses (Ries 2017; Weissbrod & Bocken 2017).

Figure 2 includes the process taking in the project. In this case study, we focus on the experiments that focused on slowing resource loops. The authors were all involved in the research project. Insight from the case study was acquired through workshops and meetings attended (observations and recordings), documents and templates used during workshops, materials prepared in advance of meetings and workshops, notes taken during and after meetings and meetings and discussions and interviews with project members.

We split up the findings according to outcomes from the experimentation process and outcomes from the sewing club experiment focused on slowing resource loops. We also discuss additional experiments emerging from the sewing club experiment.

Experimentation process findings

The project largely followed the steps in Figure 2 and during the project the focus was on *ideating*, *experimenting* and *refining*, and repeating this process multiple times. The process was effectual; the project team was building on emerging opportunities inside and outside the business, and continually engaging with key stakeholders (e.g. senior management) and bringing in new stakeholders (e.g. NGOs, other societal actors) that could support the project (Sarasvathy 2001; Bocken et al. 2018). This emergent approach is also similar to the Lean Startup approach (Ries 2011). However, some broad recurring activities emerged throughout the project: prepare market, customer and environmental data; conduct stakeholder ideation workshop; generate new solutions for further analysis; run experiment to gather more

insight (Bocken et al., 2018). In the ‘prepare market, customer and environmental data stage’, supporting data were collected to gain a better understanding of the market potential and business traction (e.g. searching for growing startups, market reports and trends and investigating how it would fit the business). Also, the potential environmental impact of options was assessed using secondary data (e.g. Allwood et al. 2006; WRAP 2012; 2017) and rules of thumb, e.g. whether the innovation would contribute to slowing, closing or narrowing resource loops (Bocken et al., 2016a). This data collection process occurred throughout the project to support arguments and gain a better understanding of the new business models’ potential.

During the first ideation and clustering phases taking place during a 2-day workshop at the beginning of the project, over 200 ideas emerged. These ideas were clustered into themes: four themes focused on extending the useful life and retaining the value of clothes, and one theme was about improving circularity by recycling used clothing (Bocken et al. 2018). This case study reports on one of the themes, focused on *retaining the value of clothes*.

The easiest way to retain the value of clothes is to make them last longer. One key strategy to do this is to maintain and repair clothes and reuse them over time (WRAP 2012; 2017). During the brainstorm the idea of a ‘sewing club’ in shops emerged to create greater awareness about making clothes last longer, build skills, and create social interactions (in the shop, amongst young and old etc.) in addition to contributing to the environmental theme of making clothes last longer. The additional social benefits envisaged made this strategy fundamental for the large retailer and the experimentation process.

Based on this, as part of a larger sustainability event, an initial experiment was set up in a retail shop. The authors attended as participants and observers. In line with the Lean Startup approach and ideas on business experimentation (Ries 2011; Osterwalder et al. 2013), some hypotheses were formulated to test traction and interest with customers. Experiment cards were developed to start mapping the experiments taking place (Appendix A for an example).

Sewing club experiment findings

Multiple lessons could be extracted from the ‘sewing club’ experiment in the clothing retail shop:

1. While initial hypotheses were formulated, there was a felt need to track all types of learning. The focus moved away from testing just the hypotheses and to understanding the broader context and business benefits of doing a sewing experience in a large retail shop. This became critically important to the business as from observations and interviews made during the in-store experiment, even onlookers (i.e. people passing the sewing experiment location) became engaged with the concept linking the sewing, repairing and generally looking after clothes and the environment.
2. The focus of the experiment was on identifying the traction of the sewing concept with customers and specific hypotheses were formulated around this. However, the initial experiment retail shop manager (who was not part of the project team running the experiments) became highly enthusiastic about the event as it created a lot of customer traction and positive responses from the public, which resulted in the retail shop running more such events. In addition, this had a spill-over effect extending the trial events to other parts of the country. Potentially, in contrast to applying Lean Startup techniques in startups, the environment in large business is so complex and unpredictable (Miller 2016), and decision-making dispersed, the potential actions following an experiment become rather unpredictable. In some cases, this may be positive, for example when an experiment has failed the hypotheses test, but gets embedded because of other reasons (e.g. community spirit; building the brand; footfall in shop).
3. It remains hard to derive environmental impact improvement from snapshot experiments. For instance, the impact of business models focused on retaining the value of materials and clothes thus slowing

resource loops will only be evident over time, in comparison to efficiency gains in manufacturing and design (narrowing resource loops) of which benefits are more instantly observable (Bocken et al. 2016a). It is recommended to test environmental impact or the ‘environmental value proposition’ while designing the business model (Weissbrod & Bocken 2017; Manninen et al. 2018).

The experiments in the shop were seen as highly successful from a business and social perspective and as such activities were absorbed in current business practices. The experiment was subsequently repeated in nine other UK store locations. However, as noted above, the environmental impact improvement and understanding of changes in consumer behaviour were not immediately evident.

Additional experiments

To generate more learning, additional experiments were set up. These included a large scale survey to test consumer behaviour. A large online survey was developed, which yielded 1009 useable responses to test people’s sewing skills, interests and knowledge and how these elements extended garment lifespans. Findings from the online survey strongly supported the link between people sewing and repairing clothing and their attachment to the garments, extending their lifespan and reducing the volumes being disposed of. Furthermore, data were gathered in desk research and in customer interviews on the benefits of making clothes last longer. The secondary data confirmed that the single most important factor to reduce the impact associated with clothes would be to keep clothing for longer – while not buying more – thus reducing total production and consumption of fibers (e.g. Allwood et al. 2006; WRAP 2012).

The findings show that even within one ‘theme’ multiple types of experiments took place, ranging from desk research type of activity to online surveys and a set up in the store. This resonates with Ries (2011)

and Schuit et al. (2017) who recommend multiple types of experimentation activities depending on the specific need.

Finally, in addition to the enthusiasm at the company itself for the concept, other large clothing retailers started to set up similar activities (or experiments) in their flagship stores, indicating that this concept provides an attractive value proposition indeed.

Discussion and conclusions

The current business models in the fashion industry are largely linear (EMF 2017). Circular business model innovation could potentially serve as a solution. However, there is a lack of frameworks supporting business model innovation within the context of the circular economy (Antikainen & Valkokari 2016). Addressing this gap, this chapter presents an overview of a method for circular business model innovation based on an experimentation approach. Experimentation with new business models is needed for long-term competitiveness (Chesbrough 2010) and addressing pressing sustainability challenges to change the way business is done (Weissbrod & Bocken 2017).

This chapter reports the case of a large retailer as an example of ‘slowing loops business model experiments’ to retain the value of clothes and thus slow the use of resources over time. Slowing loops is a possible resource strategy for achieving more circular business models but initiatives currently co-exist with existing linear business models. For instance, the sewing club initiative co-exists with existing sales models. Within the snapshot of an experiment, it is difficult to find evidence for environmental impact improvement as well as sales cannibalisation. These aspects would be more evident over time once the initiatives are put in practice. Hence, when implementing new business models sustainability concerns would need to be built in (e.g. an environmental value proposition) and progress needs to be tracked over time (Manninen et al. 2018; Weissbrod & Bocken 2017).

It was found that the social dimensions of the circular economy provide great potential for gaining traction in a business context (see also, Blomsma & Brennan 2017; Murray et al. 2015). The positive social aspects and community feel generated through the sewing experiments did create a strong case for the company to pursue these types of initiatives further. This gave the project leeway to investigate the potential environmental benefits (and how to improve the environmental value proposition) in more detail.

It should be noted that degrowth and absolute decoupling (Wells 2016), focused on absolute reductions in consumption and environmental impact, remain a challenge in particular in a single business context under increasing market pressures. Moreover, frontrunners have failed in their degrowth experiments in the past. Patagonia for instance experimented with a zero-growth model, but struggled to keep up employee motivation in a zero-growth environment (Chouinard 2006; Bocken & Short 2016).

Business model experimentation for sustainability and circularity can reveal the challenges and opportunities for a business to address sustainability and business challenges in parallel. It prompted a different way of thinking and capability within the case study retailer (as is also recommended in Ries 2017). Business model experimentation has the potential to set in motion change in an organisation (Chesbrough 2010; Ries 2017). However, to create true transformations, failure needs to be responded to with more experimentation and pivoting rather than stagnation in order to move beyond the status quo.

Acknowledgements

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Appendix A. Experiment cards used in the project (building on Osterwalder et al., 2014).

EXTENDING CLOTHES LIFE		
(a) A clothes repair service in store + (b) Sewing lessons in cafes to provide customers with basic skills to repair clothes themselves – possibility to repair clothes leads to extending the use and retaining the value of their clothes.		
Primary learning:	Secondary learning:	
Will people come to the store (a) to have clothes repaired (for a charge, only minor repairs) or (b) to acquire basic skills for repairing clothes?	Will people purchase less clothes or throw away less clothes as a result of being able to repair them (themselves or with the repair service)? Extended service: Will people come to the stores for clothes alterations and refurbishment? Will they come for a “refashion” workshop where their old clothes are transformed into new ones or other items? Social dimension: Will people come to store cafes for social activities (organised & linked to sewing)?	
Experiment description: Investigate whether people use their clothes longer if they learn how to repair them or there is an easily available service to have them repaired/minor alterations. Additionally, would people be willing to bring other clothes for refashioning and will this change their behaviours towards unworn clothes/clothes that would be thrown away? Thirdly, would a social dimension (e.g. meet-ups in store café) increase any of the above behaviours?		
DRAFT EXPERIMENT 1:	DRAFT EXPERIMENT 2:	DRAFT EXPERIMENT 3:
Demand test: Advertise a repair service on the store website, where customers can search by inputting their post code. This would gauge demand as well as geographical spread. They can be surveyed on what type of repair would they require.	Behaviour change test: Recruit xxx customers to participate in one or a set of repair classes in cafes or community rooms (recruitment could be done during sewing-related events to get access to early adopters and by other means to get two control groups). Opportunity to test during a sustainability event.	Behaviour change: Organise workshops for transforming old clothes into new ones or other items (bags, phone cases etc.). Customers bring their old clothes and their ideas to modify/remake them and the company help them to realise it. A first test could be done during a sustainability event, but will need to repeat in other locations to for the completion of the experiment.

Additional qualitative questionnaire (online or in person surveys): would people be interested in such a service? Would it make a difference to have the service offered by a trusted brand in a convenient location? Would they buy less clothes/throw away less clothes/wear their clothes more as a result of having them altered?

Key learning: is there demand for such a service; what are the best locations to place a physical shop?

Extension: Based on results, set-up a physical location to place a pop-up alteration shop in a store. Analyse activity and interview customers: are they satisfied with the service? Do they buy less clothes/wear the repaired clothes more as a result of having them fixed?

Key learning: do they find it useful? Do people go back home and repair their own clothes? Do people buy less clothes? Do people use their own clothes more?

Key learning: Do people perceive a value increase to their clothes? Do they use them afterwards? Does this reduce the number of clothes they buy?

Additional details

What are the issues we are trying to address with this solution:

Disposal of clothes with minor damage, e.g. missing button/s. Lack of knowledge on repair and alterations, even in local shops.

Additional questions we might need to understand better:

If people are willing to come to store cafes for social activities, is there an opportunity to organise other events such as swapping events?

Ride on the maker-movement wave.

Desktop research:

Analyse data from store repair service regarding the most frequent alterations we perform at the moment.

Work with other established alterations shops to understand the types of alterations they perform.

Any other research available on why people throw away clothes (from secondary sources)

Repair guides online: if repair advice/guides are available online, would people be interested on them? Would they use them?

Textile Waste

08

A Consumer-centered Approach for Managing Post-consumer Textile Flows

Kerli Kant Hvass

Post-consumer textile waste is an increasing problem throughout the world. To a great extent, post-consumer textile waste is a consumer affair as consumers decide if a garment ends up in a waste bin or elsewhere. With adjusted user behaviour and awareness of textile reuse and recycling possibilities, products can be used for a maximum length of time and further recycled into other products and materials. This chapter argues for the need for a more consumer centered approach to post-consumer textile waste and proposes a multicomponent and integrated solution for collecting consumers' unwanted clothes.

Keywords: Circular economy, post-consumer textile waste, reuse and recycling, consumer engagement



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Circular economy of fashion

Circular economy has over the recent years become a buzzword for the fashion industry and an increasing number of initiatives and business models have been introduced to the market that focus on resource efficiency and product end-of-life issues with the aim of transforming the industry from linear to circular (Kant Hvass 2016). The concept of the circular economy has many variants and a rich set of historical antecedents. One of the first conceptualizations is from Stahel (1994) who links circular economy to resource cycling where two circles are highlighted: product-specific loop that focuses on reuse and product-life extension practices and material-specific loop, that focuses on material recycling. Circular economy aims to design products and optimize production to eliminate waste by enabling efficient reuse of products and recycling of materials. In the context of the fashion industry, circular economy means minimizing waste through a product's entire life cycle by designing products that are durable and recyclable, applying more resource-efficient and sustainable practices within production, prolonging the life of garments by repair and reuse and finally integrating recycled fibers in new products, thus minimizing the use of virgin materials (Kant Hvass 2016).

The majority of the current fashion industry is still dominated by a linear “take, make, dispose” economic model, which relies on large quantities of cheap, easily accessible materials and energy. The rise of fast fashion over the past two decades has accelerated the throughput of products and with it resource demand. The fashion industry's work addressing sustainability has primarily been focused on minimizing social and environmental impacts in the supply chain, and circular or full life cycle perspectives for garments is a relatively new phenomenon. The industry's focus has changed over the last few years and there is increasing attention on circular economy within fashion and textile industries globally. This is well explained as global clothing production and sales of clothing have doubled over the last 15 years (EMF 2017), the production of which has brought along an increased use of

natural resources and the growing volume of garments that needs to be disposed of. At the same time, worldwide, clothing utilization, i.e. the average number of times a garment is worn before it ceases to be used, has fallen 36% compared to 15 years ago (ibid.). In addition, while textiles are considered nearly 100% recyclable (Hawley 2009), recent statistics show that around 73% of the world's used textiles end up in landfills or incinerators (EMF 2017). This presents a huge loss in material, as well as, economic value.

Transition towards circularity in the fashion industry requires changes throughout many components of economy and society. The market needs products that are designed for long life and for end-of-life recyclability, well-functioning and convenient garment collection systems, sorting procedures that can efficiently serve both the reuse and recycling markets, recycling technologies that can recycle textiles into high quality fabrics and other products, consumer readiness to buy used and recycled products, and brand commitment to uptake recycled fibers in new collections (Kant Hvass 2016). This needs to be supported by legislation in order to turn textile waste into valuable material that can compete with the price of virgin materials and substitute the use of virgin materials.

The problem of post-consumer textile waste

One of the biggest challenges of circular economy within fashion is the increasing volume of post-consumer textiles that ends up in global landfills or being incinerated (Hawley 2009; 2015; Bartlett 2012; Fletcher 2008; EMF 2017, Birtwistle & Moore 2007). For example, in Finland approximately 72 million kilograms of textile waste is formed annually, from which only 20% is collected separately (Fontell & Heikkilä 2017). Worldwide, 73% of material that enters the clothing system is lost after final garment use, being either sent to landfill or incinerated (EMF 2017). To capture the value of these lost garments is

challenging since consumers do not have any obligations to send their clothes for reuse and recycling and there are currently no direct governmental initiatives to ask consumers to do that (except from France with their EcoTLC system). However, several authorities in European cities have directly or indirectly increased their engagement with used textiles, driven by their circular economy or waste prevention agendas (Watson et al. 2018). For example, to increase transparency in clothes collection, city authorities in Copenhagen, Gothenburg, Antwerp and Albano Laziale in Rome have developed accreditation processes for collectors, including qualification criteria, codes of conduct, and reporting responsibilities (ibid.).

New-clothing consumption is closely linked to the used-clothing industries, and the rapidly increasing volumes of new clothes entering the market has a direct negative impact on secondary markets. While clothing production and consumption of new products has almost doubled over the last 15 years (EMF 2017), the secondary and end-of-life markets of used garments and textiles have difficulties in keeping up with the output speed. This applies both to collecting, sorting, reselling, and recycling. The supply of used garments within global markets exceeds demand and many of the secondhand markets are saturated. For example, several African countries are planning to establish import taxes for used garments to protect their own industries (Katende 2017). The biggest challenges are the increasing volumes of low quality fast-fashion goods, which have limited resell value on global markets and low prices for recyclable textiles (Watson 2018). In the end, far from being recycled, most fabrics today are “downcycled,” thus getting transformed, for instance, into carpet underlay or rags (Franco 2017).

The first step in diverting clothes from waste streams is their separate collection. The current collection system of post-consumer clothes and textiles is fragmented and consists of different actors such as charities, municipal recycling centers, social enterprises and several for-profit businesses. Recent years have also added fashion brands with in-store garment collection services (Kant Hvass 2014; Fontell & Heikkilä 2017). The dominant actor in many countries is still the non-profit charity

organization (Hawley 2006; 2015; Palm et al. 2014). For example, in Sweden charity organizations which collect and handle (i.e. sort and resell for reuse and recycling) used garments represent an estimated 90% of the market and the remainder is handled by private actors (Palm et al. 2014).

Fontell & Heikkilä (2017) have modelled the future circular business ecosystem for textiles across the whole value chain. The ecosystem model describes the main material flows from one actor to another along the value chains and illustrates the needed actors, their roles and their interdependencies in used textile flows. It illustrates how fragmented the system is with different actors that often span from local community to global reuse and recycling markets and how prolonging the life of a garment through reuse and recycling requires many independent actors to collaborate and commit to building the circular textile ecosystem.

Previous mappings of the post-consumer textile waste system (Hawley 2006; 2015) provide a good overview of the myriad of organizations which have a role in the collecting, sorting, reselling, and recycling of textiles. They fail to highlight, however, the role of the consumer/user at the centre of the circular fashion eco-system (Fontell & Heikkilä 2017). At the same time, there is a lack of garment collection solutions that provide easy, convenient and economically motivating solutions for consumers' unwanted clothes. There is a degree of hassle related to today's services, for example charities often want reuse garments of quality – which can be difficult to define and is subjectively understood – while consignment stores are only interested in high quality branded garments, and therefore consumers lack a one-stop solution for their unwanted clothes.

Consumers as gatekeepers in post-consumer textile circularity

Fashion and textiles are one of the largest consumer goods categories in the world and therefore the transition from a linear economy to a circular economy requires strong consumer commitment. Clothes are worn by everyone and for many people clothes are an important expression of individuality. Consumers have responded to the falling prices of clothes by purchasing higher volumes of clothes while using them less and getting rid of them more frequently than compared to 15 years ago (EMF 2017). It is assumed that as fashion consumption increases the volume of unwanted garments (Weber et al. 2017) and the rate of textile disposal increases (Lang et al. 2013). Research additionally argues that up to 70% of garments in peoples' closets are inactive (Fletcher 2008). Often these inactive clothes in the closets lose their aura of newness and they become unfashionable or worn out in the eyes of the owner. To make space in closets, people are constantly seeking ways to get rid of these inactive clothes.

From the perspective of linear economy, a garment accrues value through a number of steps, such as design, production, retail, marketing, and branding, and reaches its maximum value when it is sold to an end customer. From the circular economy perspective, the consumer is not the endpoint of a product's value as the product continues to retain value in the end-of-life phases for different actors in the fashion and textile eco-system. When the consumer is finished with a product, the value of that product is at its lowest for that consumer; however, the value starts increasing again once the consumer decides not to discard the product in the trash bin but to forward the product for reuse and recycling. Hence the circular economy perspective introduces new values associated with a garment and the end consumers or users, with their values, attitudes, and behaviour are the key enablers of this value-creation process. This is supported by Stahel (1986) who argues that a product's lifecycle is primarily determined by the user and not

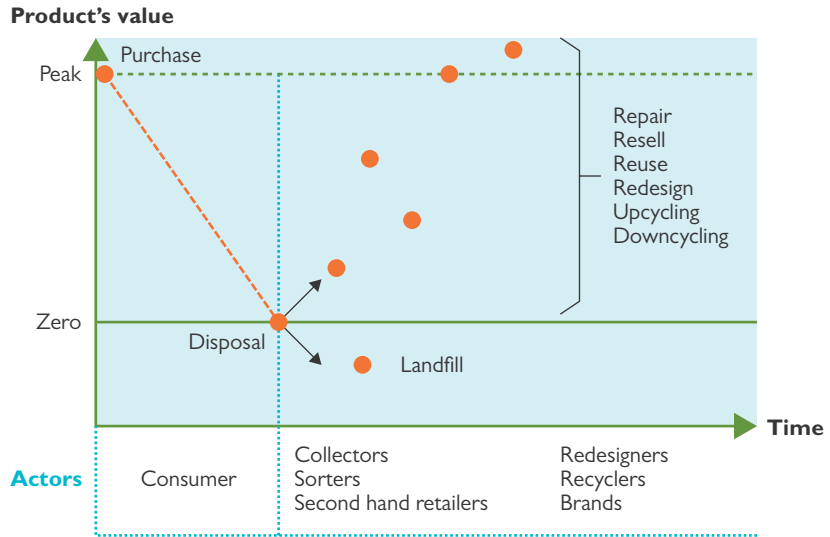


Figure 1. Post-consumer value of garments (Kant Hvass 2016; adapted from Brodin & Anderson 2008).

the manufacturer. Therefore, it is very important to collect used clothes from the end consumer and to transfer the ownership of the garment to different actors in reuse and recycling industries who can then develop and capture varying amounts of value from these garments.

Figure 1 illustrates the consumers' gatekeeper role in the post-consumer textile value system. It commences with a consumer's purchase of a product where the product's value (i.e. monetary, extrinsic and intrinsic) is at its peak. During the use phase the value decreases and reaches its lowest when the consumer is ready to dispose the product. The disposal moment is when the consumer stops using the product and makes a decision to reuse it in his/her household, discard or send it further in the system for reuse and recycling purposes; it is at this point that the product's value transformation commences. The future value of the product is therefore strongly affected by a consumer's disposal decision and the chosen disposal channel.

Hanson (1980) has described disposal as a process where a series of decisions are made. There are two decisions that are the most critical – to stop using a still-usable product and to choose among the various disposal options. Various factors may instigate the decision to stop using a product, such as the physical and psychological changes of the

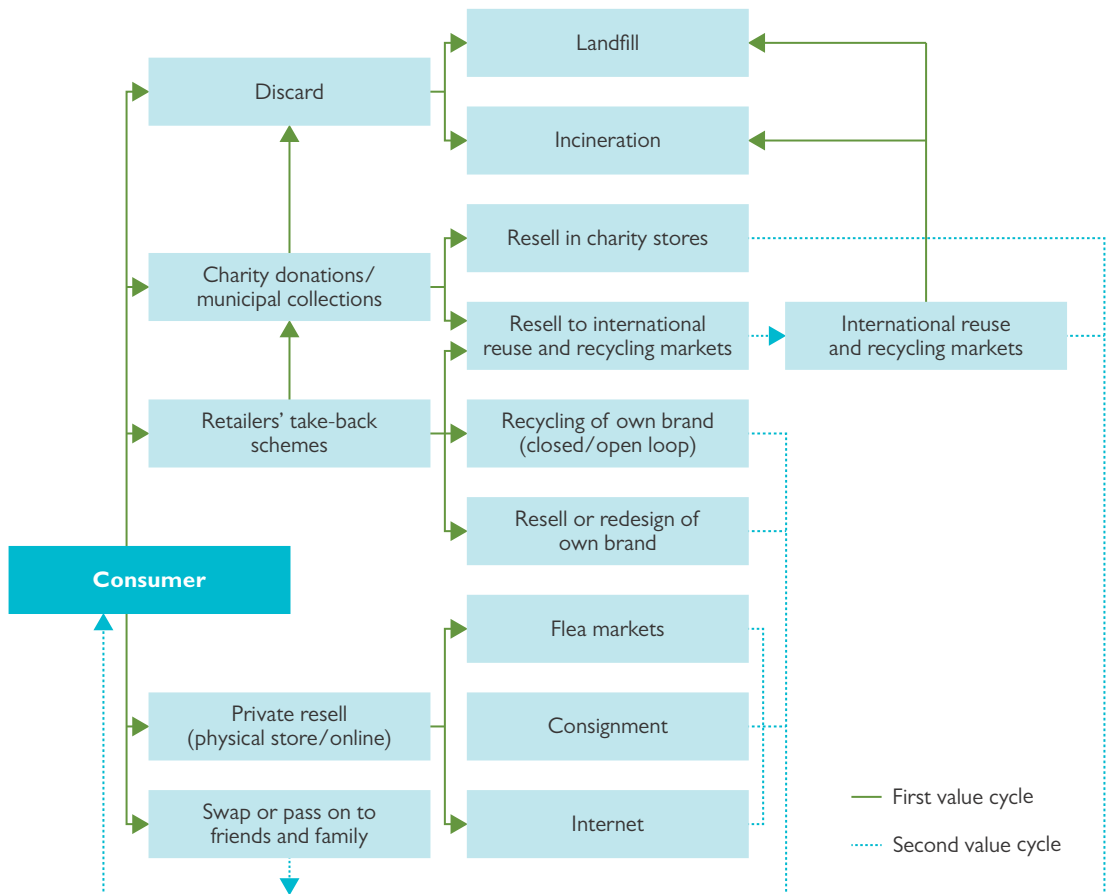


Figure 2. Post-consumer textile waste value system (Kant Hvass 2016).

consumer, his/her search for variety, changes in fashion, obsolescence of the product and the appearance of small defects in the product (Jacoby et al. 1977; Koch & Domina 1999; Morgan & Birtwistle 2009). The other important decision in the disposal process is the disposal selection method. People select various disposal channels for their unwanted clothes. The Figure 2 illustrates five main channels for consumers to manage their unwanted clothes: swapping/passing on to family or friends, reselling, in-store take-back schemes by retailers, donating, and disposal. The options are similar in that they involve consumers who voluntarily relinquish control of their garments, however they differ in terms of consumer compensation, the convenience of using the option and the amount of time involved with each channel (Weber et al. 2017).

Currently, the main method for consumers to dispose of their unwanted clothes is via donations to charity (Domina & Koch 1999; Birtwistle & Moore 2009; Ha-Brookshire & Hodges 2009; Weber et al. 2017), thus the garment reuse and recycling system relies greatly on consumers' altruistic behavior (Brodin & Anderson 2008). Historically this has been sufficient to keep the system operational and help to keep millions of garments out of landfills, but with the rapidly increasing volumes of unwanted clothes and the decreasing natural resources worldwide, this solution is not sufficient.

Past studies have demonstrated that the preferred disposal method for consumers is based on convenience and accessibility. This means that the proximity of textile collection services (e.g. recycling stations, donation sites, resell businesses) plays a deciding factor whether garments get reused, recycled or discarded into the waste stream (Shim 1995; Domina & Koch 1999; Ha-Brookshire & Hodges 2009; Morgan & Birtwistle 2009; Fortuna & Diyamandogly 2017). Additionally, consumers perception of the reuse and recycling value of the product plays an important role (Fortuna & Diyamandogly 2017). Nonetheless, consumers are often not able to adequately distinguish between reusable and nonreusable textiles (Fontell & Heikkilä 2017) or whether the garment has recycling value, and therefore they discard their used clothes into the waste stream because of stains, damage, or signs of wear and tear (Laitala 2014).

Weber et al. (2017) compared fashion (i.e. consumers with a strong interest in fashion) and non-fashion consumers (i.e. low interest in fashion) in their disposal habits and found out that fashion consumers show a stronger interest in what to do with their unwanted clothes than non-fashion consumers, and therefore alternative strategies for their engagement are recommended. Jena and Sarmah's (2015) study on consumer behavior with regard to returning used products in the electronics industry shows that besides a financial compensation, awareness and education associated with product return-related issues and benefits are important. This supports the argument for a collection system that strongly involves customer relationship management, where consumer engagement, education and motivation are in focus since the whole circular fashion system is strongly dependent on consumer behavior.

Need for innovating collection infrastructure

Access to the necessary amounts of used products is argued to be one of the key challenges of circular systems (Geyer & Jackson 2004; Guide & van Wassenhove 2009). Despite the myriad of players on the collection market, research shows that there is a need to increase the volume of textiles collected because a significant volume of used textiles ends up in municipal waste that is then landfilled or incinerated (Palm et al. 2014; Bartlett et al. 2012; Allwood et al. 2006; EMF 2017). Transitioning the fashion industry towards circularity and increasing the reuse and recycling of textiles calls for more comprehensive collection networks from the current operators or the entry of new operators into the field (Dahlbo et al. 2017). Alternative options for collection have been suggested such as: door-to-door household collection, cash-for-clothes, collection from businesses, curbside collection or in-store collection by retailers (Bartlett et al. 2012). Krikke et al. (2013) argue that multi-channel collection may be needed for customer convenience and increased return rates, which is further supported by Watson et al. (2014)

who argue that a partnership with local charities, brands and local municipalities, or a mandatory industry-wide approach might be needed for the collection of critical volumes. From a consumer perspective it requires infrastructure that is easy to use and incorporates consideration of cultural differences.

A recent report by the Ellen MacArthur Foundation (EMF 2017) supports the above and highlights that convenience, awareness, trust, and incentives are the main factors that should be considered when creating or scaling garment collection solutions. To create awareness and trust, a clear communication message is necessary, which explains that both reusable and non-reusable textiles are accepted and that these will be reused and recycled to the extent possible (Watson et al. 2018). Furthermore, Watson et al. (2018) suggest a common brand for all types of collection activities, containers, and actors to reduce confusion among consumers and to strengthen communication in relation to where to put used textiles. For example, in Rotterdam it was found that contamination by non-textile waste was reduced by giving all containers the same single color, placing them above ground and away from waste containers (*ibid.*). Weber et al. (2017) furthermore argue that fashion consumers are more likely to participate in alternative disposal methods such as resell, swap, and take-back when discarding their unwanted clothes, which identifies a need to design collection strategies accordingly (*ibid.*).

Finally, earlier research suggests that a financial incentive is often needed in order to increase the collection of used products from end-consumers (Geyer & Jackson 2004; Guide & van Wassenhove 2009), which still rings true today. When looking at current disposal solutions the emerging trends are various resell platforms (i.e. both online and physical) and in-store take-back schemes, which offer consumers economic incentives for their products. One of the companies that has built their business model around the argument of consumer convenience and incentivized product collection is Swedish start-up, Sellpy. They offer consumers a service where their unwanted goods (i.e. garments and other products) are picked up for free and after evaluation

and sorting they are resold in a webstore. Consumers can influence the price of the product and earn money on their goods. Their business model is focusing on reuse-value products, and the items that they cannot sell in their online store are further donated to charities for reuse and recycling.

These incentivised solutions are in competition with the charity market which has seen a decrease in donation quality in recent years. At the same time, high quality garments entering sorting facilities are an important element in subsidizing sending non-reusable, low quality garments for recycling, as the market price for reusable clothes is typically far higher than the price for recycled clothing; currently, the resell markets cross-subsidize the recycling markets (Morley 2013; Palm et al. 2014; Zamani et al. 2014), which makes the recycling of clothes currently less attractive than reuse.

The author argues for a need for a more systemic and collaborative approach to address post-consumer textile waste that evaluates and adds value locally to used garments and compensates customers with a share of the remaining value when possible. In the next section, a holistic consumer-centered circular supply chain framework is proposed: a one-stop site for all clothes with value recognition and capture.

A consumer-centered post-consumer textile collection approach

As discussed previously, there is a need for consumer-centered garment collection solutions that take into consideration user convenience, clear communication, and include an opportunity for compensation. The next section proposes a conceptual model for post-consumer textile collection that puts consumer interest in the center with the aim to make reuse and recycling of textiles a norm.

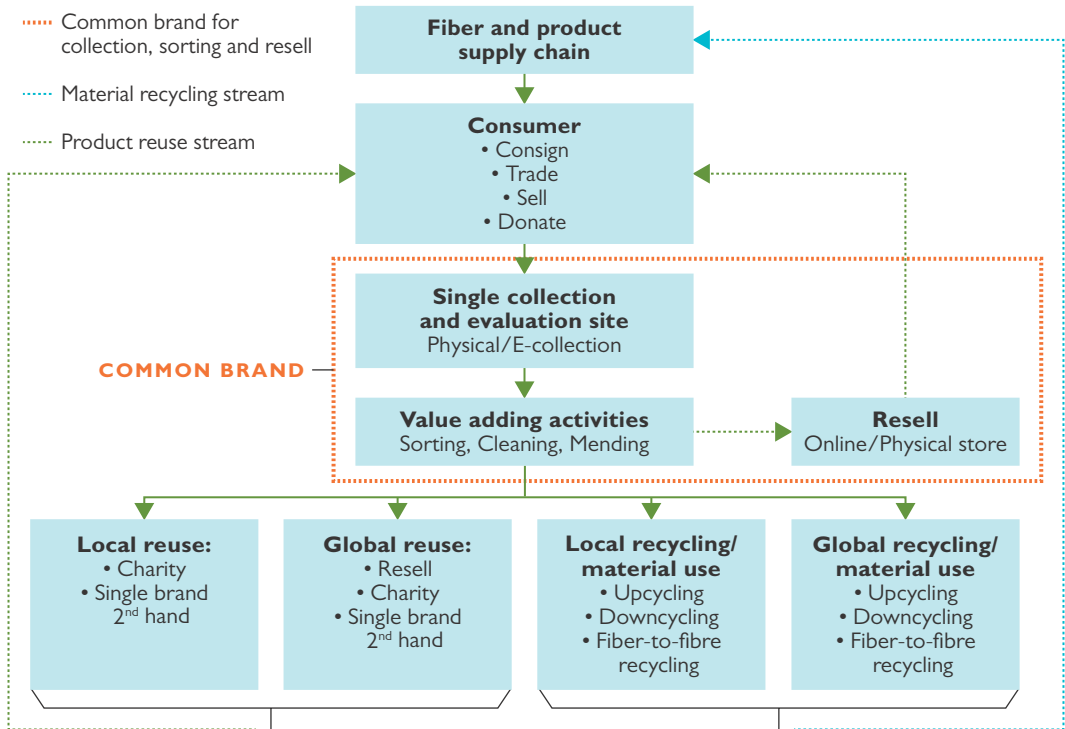


Figure 3. A consumer-centered post-consumer textile collection approach.

The model presented in Figure 3 offers end-consumers a one-stop service for all their unwanted clothes. The service is segmented according to product quality and consumer need. This includes both physical drop-off sites and mail/pick-up service. The consumer does not have to evaluate the quality of the garments at home (e.g. product reuse value or material recycling value) and the consumer is offered four options for their clothes:

1. **Consignment:** This is dedicated to high quality and high-end items where the consumer is compensated with a share of the revenue once the product has been sold.
2. **Trade:** The collector evaluates the items and the consumer receives a credit that can be used in the resell store (online or physical) or a share of the revenue once the product has been sold (often lower than a consignment share).
3. **Sell:** The collector evaluates the items and pays out cash immediately based on the lowest value of the products (often lower than both consignment and trade).
4. **Donate:** This option applies to low quality items that have no local resell value and are primarily destined for reuse and material recycling in other markets.

The service is organized by one common brand that collects, sorts, evaluates, and resells products in multi-brand resale stores. The surplus garments that are not utilized through the multi-brand resell stores are further donated/sold to other actors in the textile waste eco-system. The downstream activities are local and global reuse (e.g. donation to charities, resell to brands or other for-profit resell businesses) and local and global recycling (e.g. local and global upcycling designers and companies, local and global downcycling and fiber-to-fiber recycling initiatives). To achieve the convenience and transparency of the service, digital technology is required that facilitates the evaluation and pricing of the products, tracking of products and material flows and managing customer accounts for value compensations and customer relationships.

The key activity in this approach, besides collecting, is the sorting and evaluation of garments that serves the needs of both reuse and recycling markets. Circular economy aims for local value creation as much as possible. In after-use markets, sorting is the key activity that enables the adding of value to garments. In order to capture the recycling value of low quality garments destined for recycling, post-consumer materials need to be accurately sorted according to their exact fiber composition.

This is often challenging when done manually and therefore the potential recycling value can be lost. For textile recycling purposes there is a need for an advanced technology that can identify the exact material content, deal with the complexity of the mixed materials used in garments and be able to process large volumes efficiently. Charities, whose mission is primarily centered on social issues, will most likely not have the financial resources to invest in these technologies.

Consumer benefits

The greatest consumer benefits are the combined attributes of convenience, flexibility, economic incentive, transparency, and sustainable solutions for unwanted clothes. A consumer does not need to return home with unwanted items, which is often the case with consignment stores. Concurrently, the consumer can earn money on the more valuable items, which is often not the case with charities. It is the combined service of several consumer options that is unique and valuable in this concept. Furthermore, with the help of clear branding and communication, it reduces consumer confusion with regard to finding a solution for their unwanted clothes and avoids textiles being sent through the wrong channel. Many charities today only accept products that are clean and in good order as they lack facilities and resources to process the rest. However, this is very subjective and can be difficult for consumers to evaluate. When the aim is to engage consumers and get them to deliver products for reuse and recycling, the service needs to be simple, attractive and flexible.

Benefits for the post-consumer textile eco-system

The consumer-centered collection approach offers the industry a collaboration platform for strategic textile collection with the aim to facilitate the transition towards a circular textile system. Collaboration needs to be secured with logistics companies, local and international reuse

organizations and businesses, textile recyclers both locally and globally, and innovators to find sustainable solutions that allow the utilization of all excess materials in a sustainable way and keep them in the production and consumption loops. In addition, the concept provides an opportunity for collaboration with brands who are interested in reselling or recycling their own brand (i.e. integration of recycled fibers in their new collections). Instead of investing into their own reuse/resell solution they can outsource the collection and sorting and can buy their used products back. Further downstream it provides brands and manufacturers with recycled fibers, thus enabling the creation of a circular system of textiles. From the holistic perspective the one-entry solution for consumers also provides good opportunities for awareness raising and engagement with the help of marketing campaigns and other consumer-engagement tools.

Discussion

It is argued that the transition to a circular economy is a systems-level change and requires a new kind of value-creation mindset (Fontell & Heikkilä 2017; Bocken et al. 2016). Making a circular economy of textiles in reality requires therefore significant effort. This chapter focuses on one of the key aspects, which is collection of unwanted textiles.

Maintaining the highest possible value of products and materials for a maximum period requires close collaboration among the whole value network (Fontell & Heikkilä 2017). Having a convenient and attractive infrastructure for textile collection is crucial, as without the diversion of textiles from waste streams it is not possible and thus product and material circularity cannot be achieved. When developing the textile chain with a more consumer friendly collection solution, it should be taken into account that other parts of the chain need to be developed simultaneously in order to optimize operational costs and minimize environmental impacts (Dahlbo et al. 2017). Currently, textile reuse is subsidizing textile recycling and when higher quality items,

often referred to as cream, have been sorted out for resell purposes, the economics of recycling is challenged. In general, textile recycling is facing several barriers that are associated with cost, time, technology, and quality (Lu & Homouda 2014; Peterson 2015; Morley 2013; Palm et al. 2014). Therefore, transitioning towards circularity is a collective effort where many textile eco-system actors, including collectors, resellers, recyclers, as well as policy makers and regulators, need to collaborate.

While material recycling is one of two sides of the circular economy coin, the reuse of products as long as possible should be prioritized to avoid the use of natural resource for new productions. The reselling of textiles is a big business worldwide, however, when compared to overall consumption it is still a niche with a significant uncaptured potential. There is a lack of business models that take into consideration the needs of today's urban consumers who seek convenient, simple, transparent and ethical solutions for their consumption. A business concept that has successfully developed and integrated these principles into collection with sorting and a reverse logistics system with solutions for reusable and low-quality garments can be replicated and scaled.

Conclusion

Overall, a circular economy of fashion can only become a reality when there are well-functioning garment collection systems, sorting procedures that can efficiently serve both the reuse and recycling markets, recycling technologies that can recycle textiles (including mixed fiber fabrics) into high quality fibers and fabrics that meet market needs, and also consumer readiness to reuse, recycle, and buy second-hand products or products with recycled fiber content. None of these aspects can work in isolation, requiring different stakeholders to work in tandem. The collection of unwanted garments from consumers is one of the key steps in this transition. This chapter has argued that consumers should be regarded as an important part of the circular textile eco-system. There is a need for an infrastructure in place supported by

communication that provides clear information on consumers' roles in making circular economy a reality, what they need to do, and the transparency about the fate of their clothes. By prioritizing the customer experience and making collection and resale models convenient, accessible, and economically attractive, the resale and recycling of textiles can become a norm.

The proposed consumer-centered collection approach is conceptual in its nature and does not discuss implementation-related details. Furthermore, it does not evaluate how this model interplays with the existing textile eco-system actors and their business models, such as charities, municipal waste-collection services, resell organizations and recyclers. Finally, the author has delimited the discussion from addressing other external enablers of such a concept, such as legislation. More research is needed in order to understand the applicability of the concept in real life settings.

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Textile Waste

09

Review of Textile Recycling Ecosystem and a Case of Cotton

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The demand for textile fibers is increasing and therefore the production of natural fibers is no longer sufficient to cover the increasing fiber demand. This chapter reviews selected aspects of the circular economy of textiles. Especially the focus is on the industrial scale recycling of textiles. For this the collecting and sorting of textile waste, new technologies as well as totally new business ecosystems are needed. Since such an operational circular ecosystem is not yet a reality, modelling work related to the circular ecosystem of textiles as well as related work carried out in The Relooping Fashion Initiative project is used as a basis for this text. One emerging technology, cellulose carbamate, for enabling the future textile ecosystem is presented more in detail in this chapter.

Keywords: Textile recycling, recycling ecosystem, carbamate technology



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Introduction

The demand for textile fibers is increasing along with a rising population and living standards, and the annual use of textile fibers has recently exceeded 100 million tons per year globally (The Fiber Year 2017). The production of natural fibers is no longer sufficient to cover the increasing demand, with, for example, cotton production stagnating to around 120 million bales (21,6 million tons) annually since 2005 (Statista 2018). After the invention of plastics the amount of synthetic fibers has been increasing steadily, and the share of cotton and other natural fibers is currently around one third.

Cultivation of cotton requires typically large amounts of irrigation water, fertilizers, pesticides and herbicides. It can be considered non-sustainable from both an environmental as well as a social point of view since the land and water needed for cotton cultivation may also be needed for the cultivation of food (Haemmerle 2011). Synthetic materials, on the other hand, originate from non-renewable raw materials dependent on oil resources and, furthermore, synthetic textile fibers are a big source of microplastics (Henry et al. 2018; DeFalco et al. 2018), which are causing problems for the environment and living organisms. Simultaneously, the amount of textile waste is increasing, and vast amounts of un-sold products will end up as waste directly from the retailers (Redress 2016; Patton 2018). The use of recycled textiles as raw material for new textiles seems an attractive option to resolve both of these problems; to find a new source of raw materials for increasing fiber demand as well as reducing the amount of textile waste.

A better original quality of textiles could extend their life span and improve the re-usability of textile products and raw materials. The amount of discarded textiles in the Western world with direct second-hand retail markets is typically 10–20% (e.g. Watson et al. 2016). Of the remainder, some can be used locally for other purposes (Hawley 2006; SOEX 2017), but in many cases at least some of that amount finds its way to markets in third world countries at a very affordable price. Some of these developing countries, however, have

started to react and have banned the import of post-consumer textiles because there exists little use for low-quality textiles due to affordable new textiles, and thus second-hand, imported textiles remain as waste. There is, then, an urgent need to find high-volume processing solutions and markets accordingly for this remainder.

Over the life span of textile products, the most sustainable solution is to use them for as long as possible in the form of the original textile. However, when worn textiles are no longer suitable for reuse they should be recycled. If post-consumer textile waste is to be recycled on a large scale, properly organized collecting and sorting systems are needed (Fontell & Heikkilä 2017). Currently, however, such systems are very rare or non-existent and need to be developed. While such systems are largely missing, many of the textile waste materials are not suitable to be used for materials-recovery but end up in incineration and the production of energy.

Furthermore, many factors affect the possibilities for recycling textiles (Fontell & Heikkilä 2017). This is based on the original textile fiber composition and quality, but also the use-history of the product. Pre-consumer textiles are relatively easy to utilize due to their known composition and a quality almost as good as that of virgin fibers, but post-consumer textile waste is more challenging due to inhomogeneity, wear and tear, and possible contamination. There are several methods and processes available for textile raw material recycling, and these set some requirements for the raw materials. The Ellen MacArthur foundation (2017) divides recycling methods into mechanical, polymer and monomer level recycling. Another point of view is to divide recycling methods based on process types, i.e. mechanical, thermal and chemical recycling (Fontell & Heikkilä 2017).

Here we review selected aspects of the circular economy of textiles. The reuse of textiles is discussed shortly, but this review is focused more on the industrial scale recycling of textiles for which collecting and sorting of textile waste, new technologies as well as totally new business ecosystems are needed (sector 2). Since such an operational circular ecosystem is not yet a reality, modelling work related to the circular

ecosystem of textiles (Fontell & Heikkilä 2017) as well as related work carried out in The Relooping Fashion Initiative project (Heikkilä et al. 2018) is used as a basis for this part of the review. Those recycling technologies already available, as well as those in developmental stages, will be reviewed later (sector 3), and one emerging technology for enabling the future textile ecosystem presented more in detail. This cellulose carbamate technology (Heikkilä et al. 2018) introduced in sector 4 is one option for recycling used cotton materials into new regenerated (or reproduced) cellulose fibers for textile applications.

Circular business ecosystem for textiles

Currently, a large volume of used textiles is ending up as waste. In Europe, most waste textiles end up for energy recovery due to the banning of dumping organic waste into landfills in 2016 by the European Commission. However, in many other parts of the world textile waste will still end up as landfill. In a circular economy, raw materials are to be cycled within a looped system (EMF 2017). The circular business ecosystem for textiles is based on the principles of circular economy. This represents a model where discarded textile materials are kept within reuse and recycling loops, with the goal of maintaining the value of the material as high and for as long as possible. Within this looped system model, illustrated in Figure 1 (Fontell & Heikkilä 2017), the user – who might be either a consumer or an institutional user – has a central role.

Consumer attitudes are thus important in the circular economy of textiles (Niinimäki 2011; Fontell & Heikkilä 2017; Vehmas et al. 2018; Heikkilä et al. 2018). Consumers make choices while purchasing textile and clothing. Their values and attitudes may (or may not) lead them to select high quality and circular designs. Habits of use, maintenance and repair of textile products are also aspects of user responsibility. Thus, consumer values and attitudes, as well as skills, affect the

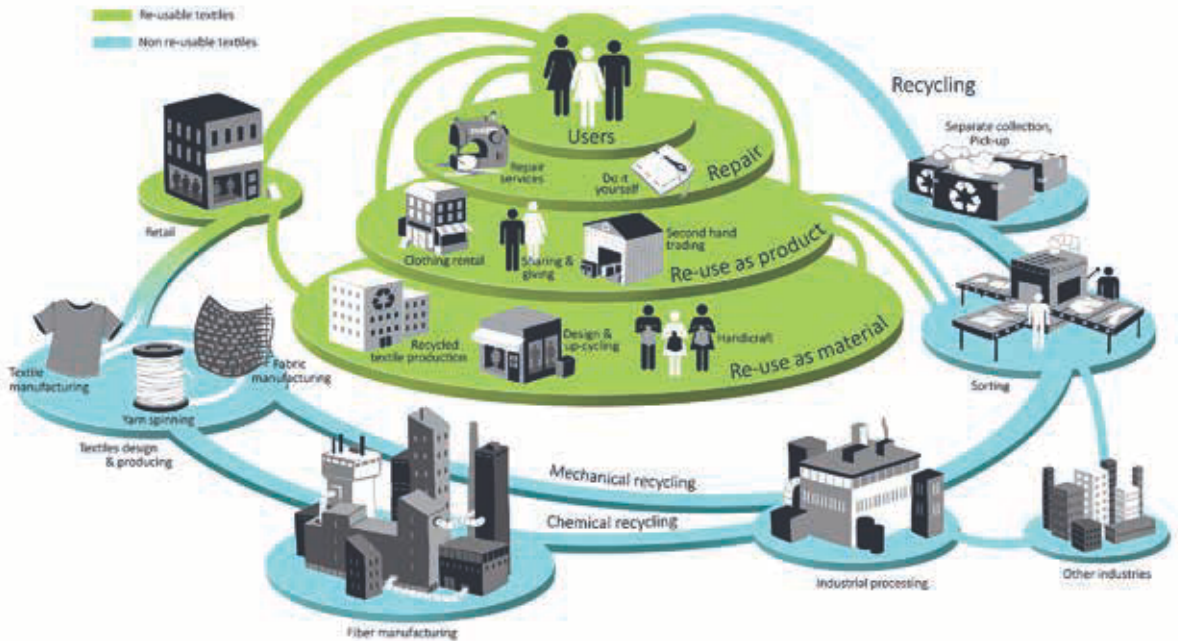


Figure 1. Model of a circular business ecosystem for textiles (Fontell & Heikkilä 2017).

life-span of the textile. User's behaviour affects the quality of material when in one's possession, and at least partly determines what happens to these products once discarded (Vehmas et al. 2018). In the future, when textile collection is more established, the user will have to make a conscious decision. They will have to evaluate whether to re-use the product or offer it up for recycling. Furthermore, they have to be able to deliver the discarded textile to the correct collection point.

One principle of the circular economy is to return the materials into cycles that best restore or regenerate their value. This means that textile products are kept within reuse cycles for as long as possible, and recycling is thus the last option after all other measures (inner value cycles) have been taken to restore and regenerate value. Reuse of textile

products is also the preferred choice according to waste hierarchy (see Figure 2), and it has been evaluated as the best choice also from the environmental point of view, based on life-cycle assessment (LCA) (Schmidt et al. 2016).

Reusing clean and undamaged clothes and home textiles is not a new concept. In former times, especially before the industrialization of textile production when clothes were difficult to produce and thus valuable, people were forced to be resource efficient. Clothes remained in use for as long as they were good enough. Damaged clothes found new life after repair and retailoring for the altered needs of the user. If a product was partially damaged, undamaged pieces of fabric were recovered and used for other purposes. When the textile product was no longer relevant for its owner, but still in good shape, it was forwarded to be re-used by other family members. Nowadays, when this is no longer a necessity, the sewing skills needed for the repair and remodelling of textile items are no longer very common. Due to increased wealth, re-use has no longer been considered a necessity as new textiles and clothes are affordable and abundantly available.

Textile markets have reached a certain maturity, and we own more textiles than we can realistically consume. People own increasing numbers of textile products, and the number of times the garments are actually worn has declined drastically (EMF 2017). The original quality of cheap, fast fashion products may be reducing use-time, and

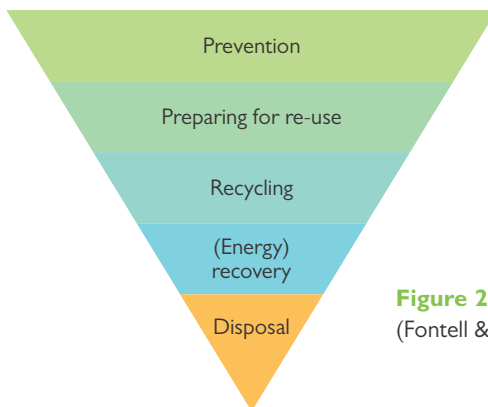


Figure 2. Waste management hierarchy (Fontell & Heikkilä 2017).

fast-changing design trends may reduce the attraction of a product or material on its second round.

Within the circular economy of textiles this needs to change; reuse has to increase, and large-scale recycling needs to be established (Fontell & Heikkilä 2017). Sustainable and circular product design strategies (WRAP 2015; TUDelft 2017; Watson et al. 2017) may help to lengthen a product's life span. Children's clothes in particular become small quickly as the child grows, and are passed further within families or to friends or, alternatively, are donated to strangers via charities. Also, second hand trading is a common practice for all kinds of consumer textiles via flea markets, second hand and charity shops, and recycling centres. With their rising popularity over previous decades, resale markets have reached a certain maturity.

Digitization and the internet have provided more tools for individual consumers to sell, swap and buy textile products themselves. Service-based business models within circular business ecosystem could develop the rental and leasing of garments towards every day and leisure clothing, not just festive and/or work clothing. When the owner is not the user but the service provider, there exists a motivation for the use of durable, high-quality materials and lasting designs.

Collecting and sorting

Charities and recycling centres have traditionally been the main actors in collecting textiles for **reuse purposes** (Fontell & Heikkilä 2017). Consumers are already able to donate clothes, for example within charity shops, charity collections in street boxes, and campaigns. The sale of the best items typically covers the costs of collecting and sorting, while a marked number of charity items are of inferior quality. The number of items actually sold, however, has not followed the amount of second hand textiles on offer. As a result, the amount of waste generated from second hand charity activities has increased.

Social organizations and those managed by municipalities, also take care of the collecting and sorting of used textiles. In this field, working

opportunities within the third sector (Rreuse 2016) are as valuable an outcome as the recycling and reduction of waste. Operations are well-organized and these social companies are able to handle large amounts of materials. They can source materials for playschools, small-scale artisanship, and for home and professional “trashionists.” Nonetheless, the same overflow of low quality materials is evident.

Buying back used textiles by brands and stores is an effective way to increase textile circulation. The concept of offering a discount on the next sold item has, however, an in-built risk of catalysing consumption. It may activate consumption decisions without proper consideration and actual need. Therefore only resalable items could become back-purchased objects and low quality items need alternative routes for recycling.

When **aiming for industrial recycling** processes, the key to the production of profitable recycled material is the efficient collecting and logistics of textile waste materials. If the post-consumer textile waste appears a mix with energy or other general waste fraction, the recovery of value-added textile fraction is seriously compromised. Value collecting from known material lots is markedly easier. For example, hotel towels and bed linen constitute a very attractive fraction compared to discarded, mixed textile waste generated as a left over from a charity collection.

Systematically arranged separate collecting and sorting of textile waste can be organized by either commercial or municipal means. These systems are thus far rare but are expected to become rapidly more common, especially in Europe. The European Commission has set a target for establishing a separate collection system for textiles within its member states by 2025 (EC 2018). Furthermore, issues for which there still exists no proper solution include the costs of logistics and handling and the best possible value-creation thereof.

The main motivation behind existing collecting has been the small portion of products that are both still valuable and sellable, which typically covers roughly 10–20% of all achieved materials (Watson et al. 2016). If separate collecting systems for large volumes of non-reusable

items are voluntary based, the selling of valuable items might be a way to cover at least some part of the collecting and sorting costs. If not subsidized, the sorting process needs to be not only accurate, but also economically viable in order to run operations in a sustainable manner. The simple picking of a few valuables may lead to dumping the less valuable materials elsewhere. To increase the overall value of waste material streams, it is vitally important to find as many high-value destinations for the recovered textile materials as possible. For example, in the future, waste management companies will have many new business opportunities for recovering the textile materials and supplying them as circular materials for different sectors. Currently, the so-called gate fee consists of objects collected from the waste handled, and yet this is not sufficient to cover the costs of resource recovery. This emphasizes combustion and energy recovery as an earning potential.

The easiest fraction from a recycling point of view is pre-consumer waste (Fontell & Heikkilä 2017). This includes, for example, cutting waste and surplus materials from textile factories and unsold clothes from retailers. In the case of pre-consumer materials, well known fiber composition reduces the need for identification and reduces sorting efforts. Material quality is still good both on a macroscopic and microscopic level, since the material has not undergone wearing and washing cycles. Materials are also usually clean and larger batches of homogeneous materials are available. Materials need a collecting system, but sorting can be quite easily organized at the point of origin, i.e., a textile factory or store.

Post-consumer textiles are more challenging because large-scale collecting and sorting systems are very limited. In many countries, the collecting of post-consumer textiles for reuse purposes is a contemporary activity within many different systems organized by charities, retailers, waste management companies, communities and many others previously mentioned. Lately, many actors have also started to accept non-reusable textiles. However, regulation might be hindering this owing to the fact that if products are not suitable for reuse they are considered as waste that only authorized organizations may be allowed to handle.

Furthermore, since fiber composition determines the possible recycling processes (Leonas 2017; Fontell & Heikkilä 2017), sorting of mixed textile waste is essential for industrial scale recycling. The most common sorting method is manual. Its benefits include the high resolution of textile quality and an understanding of its value, as well as a low threshold for arranging and initiating manual sorting. The disadvantage of requiring labour is typical of the high cost of manual work. Third sector work is often currently used when aiming for the reuse of textile products, but this does not provide a solution for the sorting of large amounts of textile waste materials for industrial recycling processes. In reality, manual sorting also requires skill and practice. Both of these properties develop only through experience on the job. Furthermore, even skilled sorters cannot make an accurate recognition of fiber types, especially in the case of fiber blends, and so advanced technology is necessary in addition to manual labour.

Automated sorting lines are available (e.g. Valvan 2018) and light-analyzing devices such as IR-spectrometers take care of material recognition (Zitting 2017). The advantage here is that the spectral analysis of materials is more recurrently precise than that achieved by human labour. The machines are typically also faster and repeat the same classification each time. The devices, however, are of low artificial intelligence and may cause major false classifications in sorting. Only recently have the first artificial intelligence devices entered the markets. These machines, however, may not be capable of identifying textiles with a high re-sale value, when, for example they belong to a known brand.

After sorting, the textile waste materials need to be pre-processed for recycling. The better the knowledge of the material's origin and history the simpler it is to decide how to handle it. All manipulation of the material increases the production cost. If unnecessary operations are eradicated, the whole process becomes both less resource-binding and more profitable. It is also possible that efficient operations are more environmentally sustainable. As a result, however, the entire material handling and logistics chain needs to be information-based, which requires digitalization to provide better transparency.

Recycling technologies

Recycling methods set certain requirements for the processing of raw materials, and thus processing options vary depending on fiber type (Leonas 2017; Fontell & Heikkilä 2017). Mechanical recycling methods are less sensitive to fiber type or even blends. Nonetheless, an equal material base improves the end quality. Chemical and thermal recycling processes, on the other hand, are more sensitive to the chemical composition of fibers. Typically, only one type of polymer applies in the production of new fibers, and if blends are used the process needs to consist of various stages in order to remove impurities either by filtering or by degrading. This is valid for dirt and other impurities which need to be removed.

In addition to homogeneity and cleanliness, wear and tear affects the recyclability of textile raw materials (Fontell & Heikkilä 2017). Wear and tear can occur on different levels: as macroscopic damage to clothes or on a microscopic level as reduced strength and length in fiber level. Macroscopic damages affect mainly the re-usability of textile products, while fiber-level wear and tear effects the possibility of recycling fiber raw materials. Since mechanical recycling does not include chemical and/or thermal processing steps, safety issues need to be considered more carefully. If recycled raw materials contain any harmful substances, they will easily be transferred into the new product. The main requirements for the different process types shown in Figure 3 and recycling processes are discussed in more detail in the following sectors.

Fiber recycling via mechanical converting

Refining textile fibers mechanically is a well-known technology. Carding has been a solution for recycling various kinds of garments for at least two centuries (IWTO 2018); wool recycling for army cloth, for example, started industrially in the nineteenth century. The recycling of cotton cutting-edges is just as viable for the denim industry.

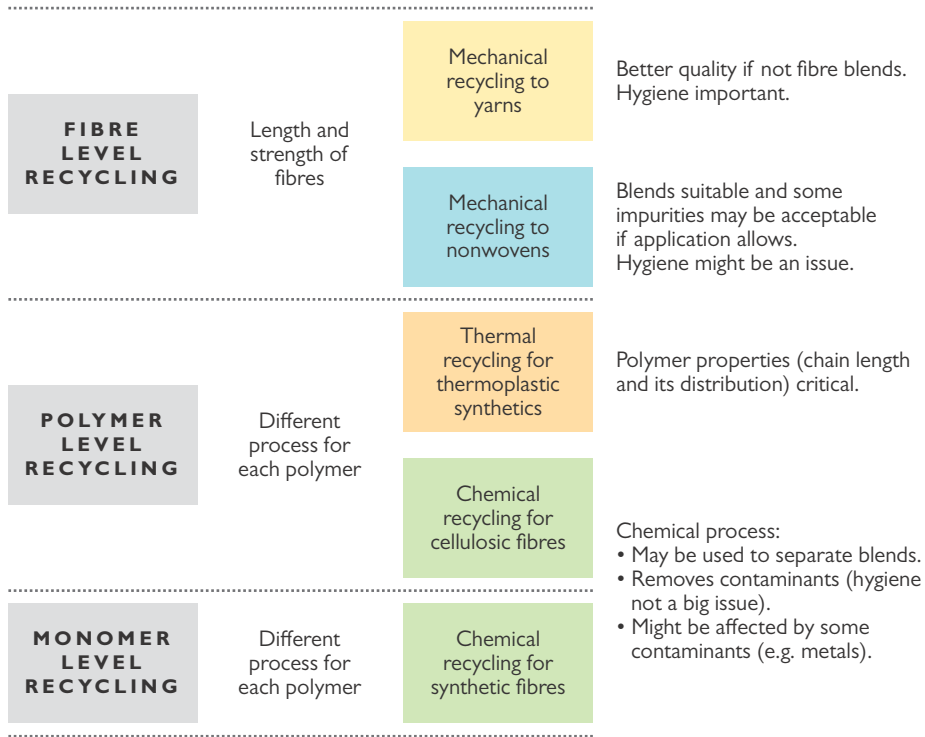


Figure 3. Main raw material requirements for different recycling processes.

To a certain extent, pre-consumer textile residuals are already mechanically recycled on an industrial scale. The typical end use of mechanically recycled fibers is in nonwovens, because mechanical disintegration is a harsh treatment during which the length of fibers is reduced (Wanassi et al. 2016). Cutting waste and similar materials are processed into yarns, typically via carding and open-end spinning in which slightly shortened fibers are also useful. In many cases, recycled fibers are completed by blending 10–30% with virgin textile fibers, but also 100% recycled fiber yarns are commercially available, for example, by Pure Waste Textiles (Watson et al. 2017).

The manual removing of buttons, zippers and other mechanical components is laborious and time-consuming. Fortunately, it is not necessary if applying special carding machinery, for example, similar in use to the Frankenhuis B.V. Modern machinery is able to separate the components simultaneously. Cutting the textile with a guillotine into strips, however, is preferable. Designers should consider the possible mechanical dismantling of the garments. For example, membrane structures and wadding may block cards easily. Removable film-prints and laminated structures may totally disable the carding process.

Mechanically refined carded fibers are suitable for typical textile processes, including yarn spinning, bleaching, and colouring. If fiber length and strength are insufficient for making yarns, an option is to produce nonwovens. Even textile dust can be recycled. Carding damages fibers and some 10–20% of material is lost as dust. The dust consists of micro polymer particles, but dust filters recover the fraction, which, for example, is suitable for the application of speciality paper. The dust is most suited for dissolving because of its fine particle size.

Raw materials recycling via thermal and chemical routes

Textile usage and maintenance weakens the fibermechanical quality of fiber. Reduced strength and length can make fibers too weak or too short for mechanical converting processes like carding or yarn spinning. When fibers are worn out on a macroscopic level but the chain length of polymers is still sufficient, raw materials can be recycled on a polymer level. In the case of applying thermoplastics, this is possible via a simple extrusion process back to fibers or to plastic or composite products.

Chemical fractionation is feasible for fibers that are worn-out on a microscopic level. Cellulosic fibers like cotton can be recycled via chemical dissolving processes. There are two alternatives for synthetic fiber materials: either re-extrusion or depolymerisation to monomer level (repeating units in polymers). Furthermore, a robust solution

is the gasification of all textile material to so-called synthetic gas, by which it is possible to synthesize materials back to different synthetic molecules like monomers and polymerize back to fiber raw materials. The molecules are alternatively converted into lower-value chemicals including fuels. Typically, these chemical fractionation methods are heavy and require large-scale production.

Synthetics. The raw material of synthetic fibers is plastic, produced by combining small, typically petroleum-derived monomer molecules in a polymerization process to form long chain polymers. Most of the common synthetic textile fibers are thermoplastics, meaning that they are objects from which new products can be formed. Fibers are producible from recycled polymers with the same spinning processes used for preparing fibers in general. When these are melt-spun into textile fibers, the process class is thermal recycling. Through this process, the fiber-length and strength of fibers can be restored, thus leaving fibers suitable for all kinds of textile processing. Thermal polymer-level recycling for PES technology is made available, for example, by Dutch aWEARness (Watson et al. 2017). Such a process means that work-clothing materials can be recycled up to eight times.

If synthetic polymers are severely damaged they can be chemically broken down to monomers, which are objects of re-polymerization, thereby restoring their polymer properties. Chemical monomer-level recycling is available on an industrial scale for synthetics such as PES by Teijin (Paszun et al. 1997) and polyamide (PA) by Econyl (Aquafile 2018). In order to produce new textile fibers from these materials, the melt-spinning process follows re-polymerization. Even though commercial processes are still rare, there is a huge potential in this field when processes develop more economically.

Natural fibers. Cotton is actually cellulose, and, moreover, a very form of pure cellulose compared to that of typical, wood-based dissolving pulp. Dissolving pulp is a highly fractionated cellulose, which is especially useful for manufacturing man-made fibers like viscose and lyocell. When recycling cotton molecules, dissolving pulp is actually produced from them first. The polymer length of cellulose obtained

from cotton is longer than that obtained from wood pulp and therefore used and worn cotton materials can, in theory, be recycled multiple times.

The requirements of the pulp are of a very high purity in respect to metal residuals, mechanical impurities and polymers not dissolving. The purification of cotton-based dissolving pulp is possible by means of preselecting and sorting the applied textile waste, washing and pre-extraction of the textiles, bleaching and filtration after dissolving. The combination of applied purification methods depends markedly on both the raw material and the spinning process. For example, it is not necessary to remove fixed colorants but they will copy onto the formed fibers (Heikkilä et al. 2018).

The dissolving pulp from cotton raw materials applies for all known cellulose-spinning processes. The main difference between the processes is the strategy for making a solution from cellulose for the fiber spinning process. Alkaline processes, i.e. a water-sodium hydroxide (NaOH)-based solvent system, include a commercial viscose process as well as a development stage cellulose carbamate (Valta & Sivonen 2002; Sivonen & Valta 2005; Cai 2007; Fu et al. 2014; Guo 2011) and Biocel-sol processes (Vehviläinen 2015). Viscose and carbamate processes rely on a better soluble cellulose derivate (chemical modificate) while in Biocelsol, enzymatic treatment improves cellulose solubility in alkaline. These water-based technologies can be applied to existing viscose wet-spinning facilities.

In lyocell-type process, on the other hand, cellulose solution is made by changing the solvent. Fibers can be produced by Lenzing's industrial process, based on N-Methylmorpholine N-oxide (NMMO) (White 2001; Perepelkin 2007), or by utilizing ionic liquids like Aalto University's Ioncell-F process (Sixta et al. 2015; Michud et al. 2015). When solvent systems have been changed, the production methods, for example the spinning and recycling of the solvent, are different to those viscose-type processes.

In principle, all the above methods are useful for the chemical recycling of cotton, but these technologies are in the developmental stage

(Evrnu 2016; Lenzing 2016; Palme 2017; Fontell & Heikkilä 2017). The properties of the reborn fibers should be the same as the respective virgin raw materials in both processing and use. The purity of the dissolving pulp, however, has a major influence on mechanical properties as well as the colour of the fibers. In practise, chemical pre-processing is essential for adjusting the properties of cotton-originated cellulose for fiber spinning. (Heikkilä et al. 2018.)

Blends. The fractionation of different fiber materials from one another is the most complicated and technically demanding operation. Garment properties are optimized by optimal fiber mixtures on the yarn level, which makes their mechanical separation impossible. The only option is fractionation on a molecular level, a method known as chemical fractionation. After this, there are two alternatives, namely selectively dissolving the polymer of certain fibers or breaking down the polymers into even smaller molecules.

Polymers dissolve selectively in specific solvents, enabling fractionation through the dissolving of one component after another. For example, CO/PES fractionation can start from either polyester or cotton (e.g. Serad 1994; De Silva 2014; Palme 2016). The second component is filtered out of the solution of the first. This second component needs dissolving only if its purity is not sufficient due to the third component, such as elastane, or other impurities.

Cellulose carbamate route for recycling of cotton

Technology

Even though cotton has favourable properties for clothing applications, the amount of cotton in the global market cannot increase sustainably. Similar pleasant properties may occur in regenerated (or reproduced) cellulose fibers, and these fibers can be made of recycled cotton. Cellulose carbamate is preferred for cotton recycling for several reasons. Cellulose carbamate technology (Valta & Sivenon 2002; 2005; Cai 2007;

Fu et al. 2014; Guo 2011) is an alternative to the viscose process because it is actually a similar alkaline spinning process and produces markedly the same kind of fiber. In other words, it is suitable as a fiber material for textile production as well as for different textile applications. The main difference between cellulose carbamate and viscose processes is that in the CCA process urea applied in cellulose solubility improves environmental impact instead of using poisonous and harmful carbon disulphide. The carbamate process can also be fully sulphur free.

Carbamate production can take place in small units distributed close to where the textile waste forms. The carbamate is a safe intermediate product, the storage times of which are long, even years, and its transportation regulations are light. This means that it also requires a simple conversion to existing viscose factories with lower environmental and working environment risk.

The overall life cycle assessment LCA for carbamate technology seems to be better than that of the existing viscose technology (Katajainen 2016). The evaluation of environmental impacts by means of life cycle inventory (LCI), and the global warming potential (GWP) of the manufacturing process of cellulose carbamate fiber, indicated 35% lower GWP value and 98% lower water consumption than the reference cotton. Compared with the same normal Asian viscose production, cellulose carbamate fiber has 66% lower GWP and 90% lower water consumption. Process integration to a pulp mill improves figures markedly because of a decreased amount of processing chemicals through efficient recovery and circulation.

Carbamate fiber and textiles

Carbamate fiber's original development target was to renew viscose production and to reduce environmental impact. In practice, carbamate fiber's production runs via the same process device as viscose with the only exception being that dissolving a cellulose derivate is significantly less harmful. This is why it has similar mechanical properties to viscose, but is softer and markedly less shiny. The appearance of carbamate fiber

can be comparable with cotton as well linen. The haptic properties of carbamate are more desirable than those of viscose.

The colour up-take of carbamate is markedly better than most other manmade fibers, meaning richer colour with a lower consumption of colorants. Beyond that, the chemical composition of the fiber provides slight anti-bacterial behaviour and reduces the flammability of the material.

Carbamate applies to all garment types, from weaved and knitted textiles to nonwoven materials. The drape of the carbamate cloth is elegant due to the gravity of the fiber. In use, carbamate textiles are comfortable, providing an impression of a cotton-like touch. The material is breathable in warm conditions and comfortable in a cool environment.

Linting of carbamate cloths is not a specific concern, because the fibers are oriented less, for example, than lyocell fibers. The pure carbamate cloth, however, has similar wet properties to viscose: the wet carbamate cloth will elongate under mechanical stress more than cotton. The features can be improved with certain chemical treatments which crosslink the cellulose molecules. A more environmentally sustainable alternative is applying carbamate fibers in mixed fiber compositions.

In cloth, carbamate fibers mix well at the yarn level with both cotton and polyester fibers. Applying different portions of mechanically recovered fibers and recycled carbamate fibers results in fully recycled cloths with optimized properties.

Prototyping and key learnings

The world's first customer-to-customer recycling piloting took place in a joint-funded industry group project, The Relooping Fashion Initiative in Finland (TEKI 2015). The textile materials for the pilot were those collected by a social company as part of their everyday materials collection and by a commercial retailer via a special buy-back campaign. Sorting the materials was done manually. Converting the cotton to cellulose carbamate and the further spinning took place in pilot facilities.



Figure 4. Carbamate fibers made from textile waste and products made from this material (photos by VTT).

These pilot facilities were small industrial processing environments, which enabled us to indicate scaling-up problems and provide information on full-scale production. Furthermore, a benefit of the pilot was to produce materials for evaluation (Heikkilä et al. 2018).

The pilot runs were successful and several material demos were completed. Most valuable were the demos, which produced readymade knitted products as a result. The demo products included, for example, gloves, t-shirts and a gala dress (see Figure 4). The carbamate fibers demonstrated also in other viscose fiber applications. Results suggest that they are also useful, for example, as stable fibers for nonwovens in hygienic textiles.

Well-defined material sources are important for successful textile recycling. Unfortunately, post-consumer textiles contain practically

every possible textile material and thus a wide variety of contamination. Because of this, one should consider the real potential of discarded rental textiles as a source for more uniform quality fractions of material.

Manual sorting is not precise, but sufficient for industrial processes. High cotton content and discarding undesired components is a part of economics. The volume of impurities affects profitability because it increases the use of chemicals in pre-treatment stages. In order to be industrially viable, then, the quality of recycled fractions and related measurements needs to be commonly agreed upon and openly communicated.

Carbamate converting is a widely known and widely available technology, and the actual spinning stage is not markedly different to viscose processing. Industrially feasible spinning fiber is currently in the pilot-ing phase. Because of these advances, the scalability of the technology and the business model both seem fully possible and achievable. The quality of the demo products also indicates that the carbamate technology is closest to solving the complex textile fractionation through an industrial process. IFC, The Infinited Fiber Company Oy, Finland, began in 2018 to pilot production on post-consumer cotton by applying the carbamate technology developed by VTT Technical Research Centre of Finland, Ltd.

Summary, conclusions and future aspects

A circular economy of textiles would provide sustainable solutions for two major challenges related to textiles: increasing demand of sustainable raw materials and reduction of textile waste. Since one of the principles of circular economy is to utilize materials in a way that best restores or generates value, lengthening the life span of textiles through good maintenance and re-use should be a primary goal. This is enabled by good quality and circular design. Recycling as raw materials should be an option for only those textiles that are no longer suitable for reuse.

Lengthening the life span as well as increased reuse requires changes in attitudes from both consumers and companies, but in principle this aspect of circularity is easier to achieve than material recycling. However, new business models require collaboration, communication, and coordination within complex networks of interdependent but independent actors/stakeholders. The challenge of re-designing business ecosystems is to find a win-win-win setting where there is a balance between the actors involved.

Although re-use is the preferred alternative prior to recycling, there are already a huge extant amount of textiles no longer suitable for re-use, and eventually all textile products will come to the end of their use-cycles. That is why textile recycling as raw material deserves all current attention within the circular economy of textiles. Many textile recycling technologies are already available, but not yet widely used commercially. In general, one of the biggest issues to solve for a circular business ecosystem of textiles is the collecting and sorting of textiles in a way that meets the quantitative and qualitative requirements of raw materials for industrial recycling processes.

As legislation is getting stricter every day, and while waste formation is not decreasing, textile recycling is the next big step necessary for the entire clothing industry. The CCA process is one of the very few viable solutions in handling and recycling cotton textile waste. The CCA process would simultaneously decrease the amount of textile waste and produce new staple fibers with a significantly developed eco-friendly process.

Currently world-wide there are some dozen projects and demonstrations of textile recycling via chemical methods. Brand owners, designers and consumers are ready for recycled products. Nonetheless, even if the time is ready, the large-scale system integrators and industrial manufactures are still missing. The reasons for this lie in the initial investment risk related to the complex structure of the entire ecosystem.

Successful business models for textile recycling are dependent on a large network of several industries and actors. The value chain from waste management to mechanical recycling exists and the whole

production chain from fiber spinning to final garment products is also in place. Most elements of the business ecosystem do exist but there is an urgent need for investment in the areas that are lacking, such as collecting, sorting, and pre-processing. Common standards and procedures could lower the investment risks, and temporary financial incentives aimed at co-creating the new recycling-based value chains would have a pivotal role in paving the way for new and more sustainable business models within the textile industry.

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The background of the slide is a textured, abstract design. It features a gradient from light blue at the top to a vibrant green at the bottom. A white, V-neck-like shape is cut out from the top center, revealing the white background behind it. The texture within the blue and green areas appears to be a fine, grainy pattern, possibly representing a knitted fabric or a digital noise effect.

Business Examples



Workwear made from polyester material can be recycled even eight times extending its lifetime even to 40 years (photo by TouchPoint).



Collaboration and Creativity in B2B Sector: **TouchPoint**

We design and produce work wear that is ecological, bold and represents a new era.

We think that with vision and an eye for creativity, almost anything can be turned into something new and functional: more stylish than old, smarter than brand new. We are dedicated to helping companies become more sustainable through outstanding design and providing sustainable and ecological solutions. Our aim is to challenge our business partners in the push to sustainability, and we assist by providing concrete solutions to achieving it. We make *returnity* clothing and take it back at the end of its useful life time. For example, using *Infinity* material made from polyester which can be recycled eight times, extending its lifetime to as long as 40 years. Our statement is to rethink and to revolutionize a prevailing disposable culture by promoting a strongly circular economy. We aim to reduce, reuse, and recycle and our aim is to use 100% ecological materials by 2020.

Landfill waste does not disappear, and burning waste produces carbon dioxide and destroys all valuable materials. This is why we have to challenge the traditional cradle-to-grave model in the clothing sector. Our design strategy for cradle-to-cradle thinking means the following:

- designing durable and long-lasting workwear
- enabling old, but still useful garments to be reused
- directing old garments, no longer useful as clothing, to other uses (e.g. redesigned into new products)
- recycling garments at the end of their life into new fibers, textiles and clothing with the help of new technologies

Easy to care, Easy to wear

TouchPoint's collaboration with the company Hesburger provides a good example of creative thinking and the reuse of old materials. Hesburger has agreed to a firm and long-term collaboration with TouchPoint in workwear and recycled products. Hesburger's new workwear collection has been made from durable, high-quality materials from start to finish, making their lifecycle considerably longer than the majority of work clothes. Shirts are made from recycled polyester (RePET), meaning that each shirt is made from seven plastic bottles.

New life for old workwear as outdoor furniture

In 2016 we started a pilot project with Dutch Awearness, which is the forerunner in circular economy thinking in the Netherlands. In this project, textile waste was transformed into composite material which is strong and weather lasting and therefore can be used in outdoor furniture. We collected from our clients (Hesburger, Meyer Shipyard, Viking Line, Hospitals) around 15 000kg of textile waste. The plastics for this composite production we obtained from Meyer Shipyard (plastics came from aluminum rolls). From this material, Dutch Awearness then produced outdoor furniture and flower boxes in return for our clients. For example, 50 outdoor table-and-chair groups were produced for Hesburger. Dutch Awearness has assured these products a 50-year guarantee, and even a recyclable life after that.

Giving new purpose through design

Can we recover and repurpose old uniforms through high quality design and thereby add value to textile waste? Using waste is a new design challenge which requires creativity and open minds. Eco-designers Anniina Nurmi and Outi Pyy designed a collection of sellable items from Viking Line's old uniforms and table cloths. The end results were a limited edition type collection of accessories which could be brought back to Viking Line on-board shops for consumers to purchase. In this way, through creative design, waste material was turned into a sales success.

10 000 scarfs for a scout event from left-over materials

In 2016 we made 18 000 scout scarfs from left-over textile materials. Because the dyeing of textile material uses a lot of water, we wanted to use the colors already existing in these left-over materials. We searched for textiles with certain colors from various left-over stocks and managed to collect around 4 km of textiles. From this material we produced 18 000 scarfs for a scout event. This exercise was especially valued by the scout organization, as it accorded with its concern to raise young people to respect the environment. This event represents a good example of how we can make valuable everyday choices in improving our environmental impact.

<http://www.touchpoint.fi/>

Outdoor furnitures made from textile waste transformed into composite material (photo by TouchPoint).





Collected and processed pre-consumer textile waste (photos by Pure Waste).



At Pure Waste Textiles, we are on a mission to change the global textile industry. We make 100% recycled, ecologically sustainable yarns, fabrics and garments, and we save a whole lot of water by doing it our way.

Cotton is a natural fiber, yet it causes severe stress to the environment. The crop uses a lot of water, but many growers are in areas where there is little rainfall. It takes around 11,000 litres of unpolluted water to grow 1 kilogram of cotton. That means a single t-shirt requires as much as 2700 litres of water. Of all the different materials, cotton is the least reused – by far.

Responsibility
in Business
through Textile
Recycling:
Pure Waste



We don't make our products from virgin material. Pure Waste recycles the offcuts and spinning waste from clothing and textile industries. The raw material is collected, sorted by colour and quality, and mechanically opened back into the fiber. Then we mix it with recycled polyester or viscose and spin it into new yarns. After that, the process is the same as with virgin materials except that our yarns and fabrics don't need to be dyed as their colour comes from the textile waste.

Pure Waste Textiles is our statement and means to affect the ever-growing waste problem. By using cutting waste as a raw material, we can reduce the amount of textile waste that ends up in incinerators or even landfills. The pre-consumer textile waste that we mainly use at the moment is just the beginning. We are also currently researching the possibility of using post-consumer textile waste as raw material. In Finland there are on-going projects related to the circular economy and the recycling of post-consumer textile waste, and we are actively involved in a couple of them. We strongly believe that in the future textile fibers can have several lifecycles. Our mission is to be at the

forefront of that development, proving that recycling can and should be done and that the textile industry can change for better.

Currently, we are mainly working with pre-consumer textile waste. When we started the business there were no guarantees that what we were aiming for would work; we just had to roll up our sleeves and start working. Trial after trial, one mistake after another, we discovered a working pattern. In our opinion the most important thing is to begin the process, even if every stage ahead is unclear or uncertain. Sometimes slow-but-steady processes genuinely move things forward, and suddenly you notice how far things have come. Thinking that a solution to a problem can only be executed once it has been *perfected* can lead to abandoning a really good idea.

Our values and beliefs firmly guide our everyday operations. We believe that we have a huge responsibility not only to the environment but also to the people working for us. We are happy to discuss and talk about our production and the processes involved. We believe that transparency is the key: certificates are important, but one should not rely on them alone. We have, therefore, adopted the policy of sharing photos and videos from our production facilities every time we visit them. We have decided to talk about the things that we are succeeding with, but also the things we are struggling with.

We have come far, but at the same time we realise that we are only at the beginning of our journey. There are many things to be changed, problems to be solved and victories to be celebrated. We believe there is still a lot that we can achieve – we just need to stay true to our values.





Giving New Life
to Waste:
Recycled Jeans
as Terry Towels
Finlayson

Old jeans can be used as a raw material
for terry towels (photos by Finlayson).



Collection

Finlayson collects jeans in their shops in Finland around the year, a practice that began back in spring 2017. In addition to collecting material in shops, Finlayson included an option for returning jeans by mail in a RePack reusable package, which made the return process easy and accessible for customers not living close to Finlayson shops. The jeans campaign was a huge success and Finlayson collected over 12,000 kg of jeans material in 2017 alone, which is estimated to be around 8,000 pairs of jeans. Finlayson takes back all kinds of jeans material: pants, jackets, overalls etc., and offers its customers a voucher that can be used for shopping in Finlayson stores and webshop.

Process

Jeans are sent from Finlayson's logistics center in Finland to Belgium, to the European Spinning Group (ESG) that uses different partners for sorting the material. In Finlayson's case, the sorting is done by Altex in Germany. All material is used but whether it can be used in the towel

making process or not depends on the quality of the material. It is estimated that 80 % of the jeans material can be used for towels. The material is sorted based on cleanliness and fiber content. Only jeans that are clean and do not contain elastane can be used in the towel-making process, as elastane is a flexible fiber and thus problematic when material is being mechanically opened back into fiber. The product labels, zippers and buttons are also removed at this stage. Metal parts are recycled, and labels burned. The jeans material is mechanically opened back into fibers and the excess material that cannot be used in the process is sent to the car manufacturing industry to be used as interior and sound proofing material in cars.

Clean jeans fiber is sent back to ESG, which has done extensive research to find the best possible composition for the thread, as recycled fibers are not as strong as virgin cotton. ESG spins the fiber into thread adding viscose to make durable and suitable thread for towels. After that, Finlayson's production partner NV Weverij J. Clarysse in Belgium takes over and weaves the thread into towels according to the normal towel-making process, except the towels are not dyed at any point.

Products

The products are designed by Liisa Suurla and are called Old Jeans Towels. They contain 40 % recycled cotton (=jeans), 40 % viscose and 20 % virgin cotton (warp). There are two sizes: hand towel and bath towel. It is calculated that the jeans towels save hundreds of litres of water compared to towels made from virgin cotton. More precisely, 1 kg of jeans towels saves 5999 liters of water, as calculated by Modint, a Dutch umbrella organization of producers, importers, agents, grossists in clothes, accessories, rugs and (home)textiles. The hand towel saves 850 liters and the bath towel over 2500 liters. With this information, it was calculated that the towels produced for Finlayson in 2017 saved over 10 million liters of water, which is the same as over four Olympic size pools.







The maintenance service lengthens the life of knitwear (photos by Arela).

Arela
Knitwear Care
Service



“Have you replaced my knit with a new one? This looks and feels like new!” is a common response when a customer comes to collect their knitwear from the care service at an Arela store. The maintenance service provided by the clothing company Arela is designed to lengthen the life of knitwear as part of company’s ethos of sustainability.

Founded in 2007 by textile designer Maija Arela, Arela is known for making modern, minimalist cashmere knits for the contemporary consumer. During Arela's early years, cashmere was a relatively unknown material in Finland, and cashmere knits in the Finnish market were few. Educating consumers about the precious material, its qualities and care became a significant part of Arela's work. Because many customers worry they will ruin their delicate knits by washing, are unable to mend holes, or are too busy for maintenance, Arela developed an care service to complete their customer experience.

To benefit from this care service, customers bring their used knits to an Arela store. Arela staff de-pill, wash and steam the knits and mend holes and seams if needed. Additional services include elbow patch sewing and alterations. The in-house care staff all have degrees in textile



or clothing and can execute skillful repairs. As a material, cashmere takes lends itself well to care – pilling is easily removed with a cashmere comb, holes can be mended almost invisibly, and washing, when done correctly, only improves cashmere’s warming and breathable qualities. The care service helps to lengthen the life of knits and keeps them in use as long as possible, in line with company’s philosophy. When using precious natural material, it is of utmost importance that the garments do not end up in a landfill. If a knit is beyond repair, perhaps after a meeting with an enthusiastic puppy, Arela takes the garment back and recycles the material, making sleep masks, elbow patches or hot-water bottle covers from it.

After introducing merino knits to their collections, Arela extended its care service to cover merino knits. But the only knits now accepted by this service are of Arela’s own brand. Because there are so many different qualities of cashmere and merino on the market nowadays, Arela can only take responsibility for the knits they know the composition of; what kind of yarn has been used has a great effect on how the knit will respond to care.

From a business point of view, the service lowers the customer’s threshold to invest in a high-quality knit, gains trust and works as a warranty. A win-win situation for both the brand and the customer, the latter experiences a pleasure not unlike purchasing a new garment, but without the guilt of consuming more.

CLOTHING AS A SERVICE MODEL

Anniina Nurmi 2017 // www.anniinanurmi.com // @nurmianniina



Figure by Anniina Nurmi.

Anniina Nurmi: 'Clothing as a Service' Will Disrupt the Fashion System

For the past ten years I have been working in the field of sustainable fashion. I have wanted to do as much as I can to enable the change from disposable to sustainable: by sharing information through the *Vihreät vaatteet* [Green Garments] website, teaching design students, managing a webstore that sells ecological clothes, and running a sustainable clothing label, Nurmi.

For years I thought I was able to do the most by running a clothing label: I used sustainable materials, produced ethically, and designed long-lasting styles. But then I realized that by bringing more clothes into this world I could not achieve a big enough change. I was still operating within the same fashion system whose core purpose is to produce more, faster and cheaper. No individual action towards sustainability within this system is sufficient when the *system itself* is the problem.

This is why I took time-out from the clothing label and concentrated on looking at the bigger picture. Already when I was still running the Nurmi label, I had gained an interest in the idea of clothing rental. I had donated Nurmi clothes to the few clothing libraries already existing in Finland, and in spring 2015 I managed a small-scale Nurmi clothing library located at our store in Lahti. Since then I have made several different clothing rental tests which have helped me learn that through renting we can build a fashion system which will truly disrupt the existing one.

Alternative revenue model

The production of long-lasting, high-quality clothes has to become more profitable than fast fashion. This change is possible with the model of ‘clothing as a service.’ A piece of clothing is turned into a service: we do not pay for a product itself but for the *use* of a product. The same way that, for example, in transportation we already have ‘mobility-as-a-service.’ The current revenue model is based on making a profit when a piece of clothing is sold. The sales profit is received once, and after that the garment doesn’t generate any further profit for the company. But in the ‘clothing as a service’ model the longer the piece of clothing stays in circulation, the bigger the profit. In other words, the higher the quality, the better the profit.

Renting makes fashion circular

Clothes can be rented out by clothing stores, labels, and yet also consumers. The renting process can happen through an app, and the piece of clothing is delivered to your doorstep or collected from a swap-point. The service can also be offered at a physical location, for example at a department store or a clothing library. To make the renting process efficient, easy and scalable, there should be a digital platform which enables tracking, transparency and communication between the owner and renter, but also between other service providers such as a laundry service and logistics partner.

After the piece of clothing is rented numerous times – hopefully for years and years – and is no longer wearable, it is returned back to its producer, because in this model the ownership of and responsibility for a piece of clothing remains with the producer. When the piece of clothing is returned, it is reused as raw material for new clothes. This way we can close the loop in an efficient way and make fashion circular.

Almost any piece of clothing can be rented, some for shorter periods of time, some for longer. For example, it would make sense to rent an evening gown just for a few days as it is meant to be worn only once. On the other hand, a winter jacket can be rented for the whole season, jeans for an even longer period of time, for years.

A win-win for consumers, companies – and the environment

Rental services offer retailers and clothing labels new ways to gain income. By renting, they can generate an even higher profit than by selling an item, because a high-quality piece of clothing can be kept in circulation for a long period of time. In addition, they are able to develop a much closer customer relationship and attract returning customers. Through the rental platform, a retailer or a label has access to a huge amount of data: about customer behavior but also about product lifecycles. This way the retailers and clothing labels are able to offer customized services, enhance the circulation of clothing and learn more about their customers.

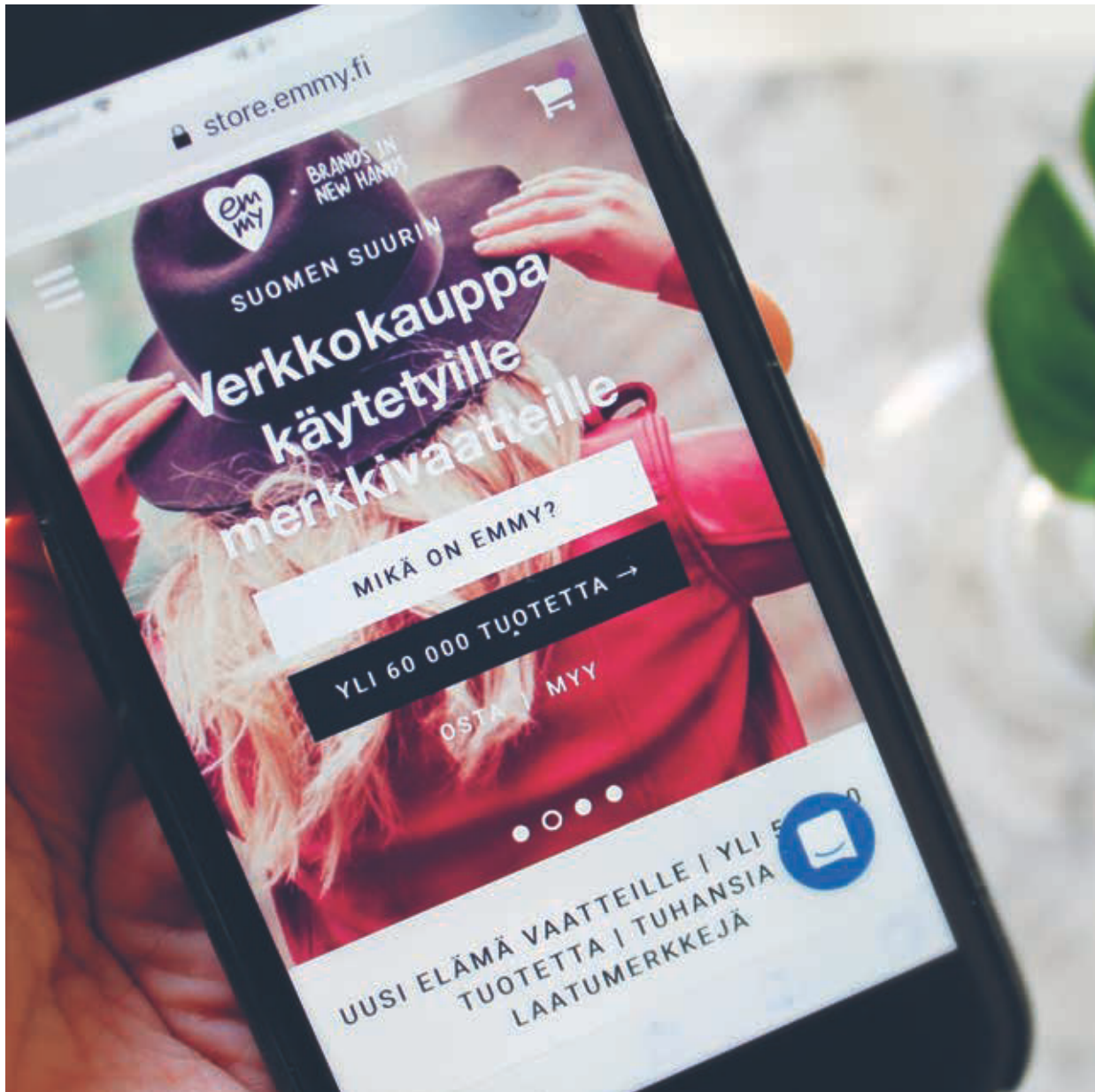
By renting a piece of clothing to someone else, a consumer can make a profit from her own wardrobe: when you're not wearing a piece of clothing yourself, it generates income through renting. As soon as you consider buying a new piece of clothing, you can think of it as an investment: "If I now invest in this high-quality, sustainable and a bit more expensive product, I can pay for it in part – or even entirely – through renting it to others."

A consumer has access to a limitless selection of clothing without the burden of ownership. By renting, you can use the kinds of quality designer items which you otherwise perhaps couldn't afford or wouldn't dare to buy.

Last but not least, renting has huge benefits for the environment. It enables us to concentrate on the quality and sustainability of clothing production, as the low price and fast cycles are not the only desirable features of our clothes. Also, because the high-quality items are kept in circulation for longer periods of time, we can produce less, which significantly reduces the environmental impact of clothing production.

We urgently need to move towards a truly sustainable and circular fashion industry. I firmly believe that the 'clothing as a service' model can make it a reality.





Emmy makes selling and buying secondhand brand garments easy (photo by Emmy).



Emmy is a pioneering service for consumers to effortlessly recirculate brand apparel that they no longer need. With 20% monthly sales growth in 2017–2018, Emmy is one of the fastest growing apparel recirculation operators in the Nordics and Europe.

Emmy's business idea was born three years ago, arising from an anxiety most of us have: what to do with the brand clothes that are in good condition but that we no longer need ourselves? Selling these items at the local flea market is time-consuming and often poorly productive, and various online fleas, auctions and social media groups generally fail to make a difference in terms of the effort required.

Heaven for
Pre-owned
Brands:
Emmy.fi



BRANDS
IN NEW
HANDS

Emmy's collection points can be found in several malls in Finland (photo by Emmy).

“As long as effortless ways to recirculation are not available, people too easily choose the worst alternative: throwing items away,” notes Juha Mattsson, CEO of Emmy. He continues: “Recently we’ve also read in the papers how different charity donation batches may have ended up in Africa or elsewhere to distort the local clothing market and industry. The best scenario would be for people to only buy products that are long-lasting and sustainable, and then to recirculate unnecessary items locally. We harness the market forces to achieve this.”

Emmy’s concept builds on making, selling and buying secondhand easier than in any other way. Anyone who wants to sell can leave their quality brand clothes, shoes, bags, and accessories to Emmy’s collection points. Emmy takes care of everything else: manually inspecting, sorting, photographing and selling the items at the Emmy online store. Emmy also adds size standardization, checks originality, and handles all shipments, returns and customer service. The two week return policy guarantees safe and easy shopping, and the sellers get up to 80% of all that gets sold. At the moment (Q2/2018) the company has around 40 collection points located typically at malls and covering all major demographic areas in Finland.

The online store’s selection currently holds approx. 60,000 unique items. During the three-year history of the business, over 250,000 items have already exchanged hands. According to calculations by the Finnish Environment Institute, Emmy has so far helped to reduce 150+ tons of CO₂ emissions and to save 300+ million liters of water. Emmy has also donated approx. 35,000 items to local charities.

“The most important thing is that the environment benefits. Emmy’s mission is to guide consumption towards sustainable and durable brands. Thanks to a well-functioning aftermarket, buying clothes becomes an investment, and the resale price of brands will begin affecting people’s choices when buying new items. At the end of the day, the amount of textile going to waste will be reduced significantly,” Mattsson says.





Do you really have to own all your clothes? How about using fashion leasing service? (photos by Maru Lemmetty).



Leasing Fashion Can Be Fun! **Vaatepuu**

Fashion leasing services offer engaging solution for women's clothing problems. We have all experienced how different kinds of garments pile up in our wardrobes, even though we have used them only once or twice. This occurs for various reasons: because of fashion experiments, sale craziness, last minute party-dresses, a desperate need for change, dresses bought for occasions where the dress code requires us to buy things we wouldn't normally wear, etc. Some fashion brands make garments to last a very short time, and it seems that the whole principle behind the business is based on the disposability of fashion.

Vaatepuu fashion leasing service was established by Soile-Maria Linnemäki in 2014, in Järvenpää.

Linnemäki had previous experience of using a Fashion Library in Helsinki and wanted to start a similar service. Now the service functions also in Turku, Tampere and Helsinki. While based in several towns, it is possible to circulate garments between different locations, and in this way refresh what's on offer. The leasing service also collaborates with Finnish fashion designers, which enables it to offer the lease of a unique evening wear collection. The service is based on a membership fee, and lending time is 1–2 weeks, with the principle of 2 items every 2 weeks. Vaatepuu is also trying out a points system whereby more expensive garments can be leased by acquiring more points.

The mission behind Vaatepuu is to get consumers to give more thought to the number of garments they are buying, and to consider the factor of quality over quantity. We are also concerned with increasing accessibility to the experience of how high-quality materials feel on your skin, how it feels to wear well-designed garments, and, in general to show how it is possible to be well dressed everyday of your life. The service helps people to discover their own style and offers clothing to suit every situation in life. Support is provided to gain a better understanding of what is worth owning and what it's better to rent. It makes sense to invest in certain base garments of your own, which will be of long-term use, and yet to lease more exclusive garments for special occasions. Vaatepuu shows that it is better to rent items you will use only once or twice.

Vaatepuu also provides guidance about how to take care of your garments, and offers a repair services when required. Through such innovation, the fashion leasing system breaks down exclusivity barriers through a more reasonable and more responsible use of clothing. It also shows the way to democratizing fashion: the service is used by leading politicians as well as artists living on a small grant or stay-at-home mums on maternity leave. We can honestly say that this service is for *everyone*. Vaatepuu also wants to show how a sustainable use of fashion can be fun and can create a supportive community. As Soile-Maria puts it “the best party is always around the shared fitting room.” Even a bad day can be saved by borrowed fashion.



Membership offers

- The use of fashion in a more sustainable way. Do you really have to own *all* your clothes?
- The possibility to develop your own style. You can try out garments you wouldn't normally buy.
- The possibility to get to know Finnish fashion. How many Finnish brands are you familiar with?
- The transformation of your wardrobe in an economical and space-saving way.
- The chance to minimize wrong purchases. If you really like the garment you have leased, you can purchase it for yourself.
- The chance to have fun! Our shared fitting room is visited by incredible women who give positive feedback to one other.

Writers in this publication

Sustainable Fashion in a Circular Economy

Kirsi Niinimäki, PhD (Doctor of Arts in Aalto University), is Associate Professor in Design, especially in Fashion research in the Department of Design at Aalto University, Finland. Her research has focused on holistic understanding of sustainable fashion and textile fields and connections between design, manufacturing, business models and consumption. Her research group the Fashion/Textile Futures, <http://ftfutures.aalto.fi>, is involved in several significant research projects, which integrate closed loop, bio-economy and circular economy approaches in fashion and textile systems and extends the understanding of strategic sustainable design.

The Clothing Style Confidence Mindset in the Circular Economy

Cosette M.J. Armstrong, PhD, is Associate Professor in the Department of Design, Housing, and Merchandising at Oklahoma State University, USA, where she teaches courses related to sustainable design and visual communications. Her research has focused on sustainability education and sustainable design. She has explored pedagogical strategies, curriculum design and engagement tools for the integration of sustainability into textiles and clothing education.

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Collaborative Consumption and the Fashion Industry

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Dr Rosy Boardman is Lecturer in Fashion Business at University of Manchester, UK. Her research has focused on digital strategy and innovation in the retail industry. In particular, her research has specialised in e-commerce, digital marketing, multichannel/omnichannel retailing, m-commerce and consumer behaviour utilising eye tracking technology and qualitative research methods. Boardman has also worked in industry as a fashion buyer and a marketing assistant.

Dr Helen McCormick is Senior Lecturer in Online Fashion Retailing and Multichannel Strategy at University of Manchester, UK. She is a specialist in retail marketing and conducts research in the area of social media marketing, consumer behaviour, m-commerce, e-commerce and s-commerce, retail design, and also areas that include new technologies and their use particularly to support sustainability, e.g. augmented reality, virtual reality and innovative technologies used in retail. McCormick is passionate about researching the changing retail environment in the UK and globally focusing on how technology can support sustainable processes in retail.

Designing for a Circular Economy: Make, Use and Recover Products

Dr Ruud Balkenende is Professor in Circular Product Design at Delft University of Technology, Netherlands. In 2015 Prof Balkenende started at the TU Delft after 25 years of experience at Philips. He has been active in several EU-funded projects and was the coordinator of GreenElec, a project that successfully implemented design for recycling. His research, projects and teaching concentrate on the connection between product design and circular economy with a focus on the engineering aspects of implementation. His research interest is in improving the resource efficiency of products through design for recycling and design for circular economy.

Dr Conny Bakker is Professor in Design Methodology for Sustainability and Circular Economy at Delft University of Technology, Netherlands. Bakker is recognized as an expert on design for circular economy. She has been active

in numerous EU-funded projects on the circular economy and eco-design, such as ResCOM, LCA-to-Go, ProSUM and GreenElec. Her research, projects and teaching focus on the connection between product design and circular economy. She has set up a MOOC on Circular Economy and Product Design that already has reached over 10,000 participants.

Design for Circularity: The Case of *circular.fashion*

Essi Karell, MA, is Doctoral Candidate in the Department of Design, at Aalto University, Finland, where she works in Fashion/Textile Futures research group. Her research focuses on fashion design in a circular economy, more precisely on design, which enables textile waste recycling. Previously she has worked in projects related to emerging technologies in sustainable fashion.

Sustainable Design Cards: A Learning Tool for Supporting Sustainable Design Strategies

Ulla Ræbild, PhD, is Assistant Professor and Head of MA Programme Planet – Design for Sustainable Futures at Design School Kolding, Denmark, where she teaches, supervises and conducts research within the fields of fashion design, design methods and sustainability. Furthermore, she has developed curriculum and explored pedagogical approaches in the context of design education.

Karen Marie Hasling, PhD, is Assistant Professor at Design School Kolding, Denmark, where she teaches courses on materials' different roles in sustainable design. With a cross-disciplinary approach, her research focuses on the interface between learning, materials and product design within the context of sustainable transition.

Slowing Resource Loops in the Clothing Industry through Circular Business Model Experimentation

Nancy M.P. Bocken, PhD, is Professor in Sustainable Business Management and Practice at Lund University, IIIIEE, Sweden. Her interest is in finding solutions to close the “idea-action gap” in sustainable innovation. Bocken is also Associate Professor at TU Delft and Fellow at the Cambridge Institute for Sustainability Leadership. She co-founded HOMIE whose ‘pay per use business model’ aims to drive sustainable consumption and ‘circularity’.

Karen Miller, PhD (Cantab), is Researcher in the Centre for Industrial Sustainability at the University of Cambridge, UK. She also teaches design and innovation management for sustainability in businesses. Her research focuses on sustainability and business model innovation, with a particular focus on the fashion and textile industries.

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Steve Evans, PhD, is Director of Research in Industrial Sustainability in the Department of Engineering at Cambridge University, UK, where he tries to find ways to help industry become sustainable, and is particularly interested in inexpensive solutions – expensive solutions are too easy. His team comes from across the globe, solving problems in Africa and Asia as well as the advanced economies.

A Consumer-centered Approach for Managing Post-consumer Textile Flows

Kerli Kant Hvass, PhD, is Research Affiliate in the Department of Management, Society and Communication at Copenhagen Business School (CBS), Denmark and a freelance advisor in circular economy and sustainability. Her research approach is engaged scholarship in collaboration with practitioners and focuses on organizational aspects of business model innovation for sustainability and circular economy, circular fashion and management of post-consumer textile waste issues. She advises companies, NGO's, start-ups and other initiatives on circular economy, business model innovation and sustainability.

Review of Textile Recycling Ecosystem and a Case of Cotton

Pirjo Heikkilä, Dr. Sc. (Tech.), is Senior Scientist at VTT Technical Research Centre of Finland Ltd in research area of fibers and bio-based materials. She has 19 years' experience in textile research ranging from fiber materials to technical applications, and during the last years Heikkilä has focused on textile recycling topics.

Paula Fontell is co-founder and CEO of Ethica Ltd, a consultancy focused on circular economy. Ethica is specialized in circular business ecosystem modelling and development across different industries, as well as coaching businesses in circular business model development. Ethica partnered with VTT Technical Research Centre of Finland Ltd in the Relooping Fashion initiative and has coached several textile companies in building new circular service concepts and circular narratives.

Marjo Määttänen M.Sc. (Tech.), is Senior Scientist at VTT Technical Research Centre of Finland Ltd, where she develops technologies to utilize cellulose based waste materials, such as textiles and cardboard waste, as raw materials for sustainable man-made cellulose textile fibers. She is responsible for wet-spinning facilities at VTT Bioruukki piloting centre in Espoo, where novel sustainable man-made cellulose processes can be developed from laboratory to pilot scale.

Ali Harlin, D.Sc., is Research Professor of new biomaterials and bio economy at VTT Technical Research Centre of Finland Ltd. He is former Professor in Technical Textiles at Technical University Tampere, Finland. He is also active as an industrial innovator and lecturer.

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The promotion of sustainable fashion within a circular economy is a vital contemporary topic. This publication presents up-to-date research about the various levels of circularity at work in the fashion industry. Experts of design, consumption, business and industry explain how circularity in the production and consumption of fashion can be approached in manifold ways. This collection of texts highlights the fresh, critical thinking that is currently influencing the fashion industry to adopt the practice of sustainable transformation within a circular economy.

The publication addresses the following themes:

- How to include consumers within the changing process of fashion consumption?
- New design and business strategies for the circular transformation of fashion.
- Developing a systems approach to circularity, which includes the recycling and recovering of materials at an industrial level.

Kirsi Niinimäki works as an Associate Professor in Aalto University, Helsinki, and is one of the most prominent researchers in the field of sustainable fashion. The contributors to this book are leading researchers in the field of sustainable fashion and circular economy. Their passion is to challenge a linear way of thinking and to promote innovative and progressive practices of circularity in the fashion industry.



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