

Dimensions of Behaviour Change in the context of Designing for a Circular Economy

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Abstract: Circular economy research has seen increasing attention over the years, but with limited attention for how to design circular solutions that actually will change user behaviour. At the same time, Design for Sustainable Behaviour as research field has so far not explicitly focused on behaviours that are particular for a circular economy. To address this gap, the paper presents product and service examples as a grid consisting of nine dimensions of behaviour change (control, obtrusiveness, timing, exposure, meaning, importance, direction, encouragement and empathy) and four goals for circular economy (maintenance, reuse, refurbishment and recycling). It is shown that examples for almost all combinations exist. Second, based on four case studies, the paper addresses in more detail how different dimensions of behaviour change are used and analyses their application in four case companies. Results suggest that all dimensions are relevant, but the variation in application differs greatly.

Keywords: Design for Sustainable Behaviour; Circular Economy; Behaviour Change; Design theory; Sustainability.

Introduction

Although the idea of circular economy has been known for several decades (Pearce and Turner, 1989) and approaches to circular design have been available for many years (e.g. McDonough and Braungart, 2002), the concept has received a substantial increase in attention over the last few years. One of the main reasons for this increased attention by entities outside of academia is the emphasis given to it by the European Union as demonstrated by the publication of the report “Closing the loop” in 2015 (European commission, 2015). On page 6 of this report the European Commission identifies the potential of designing products that are more durable, easier to repair, upgrade, remanufacture and disassemble. However, the report further points out that “The choices made by millions of consumers can support or hamper the circular economy”. To date, work in the field of circular economy has primarily revolved around materials science and economics. A lack of focus on the roles of people’s everyday activities and the designs and business models that promote or hinder these, has been noted by several authors (Schotman and Ludden, 2014, Piscicelli and Ludden, 2016, Kirchherr et al., 2017).

A recent review by Kirchherr et al. (2017) identified a lack of focus on business models and especially consumer activities in the academic literature as a barrier to uptake, and therefore we see this paper as a valuable foray into the influence of design on consumer behaviour. For a circular economy to function successfully, it is not only necessary to have systems in place to enable the various circular goals (reuse, refurbishment, recycling etc.) but also to increase the likelihood of consumers (or users) to behave in accordance with the goals. For instance, a great recycling or reuse system will not be able to recirculate the materials or products unless users (consumers or companies) return or deposit these in the correct way. In other words, when designing a concept for a circular economy, it is paramount that it is designed to encourage actors in the economy to behave in the desired way. We might call this circular behaviour design.

There are many different goals or strategies to improve the circularity of an economy. Several studies have provided frameworks and principles for circular design and practice, advocating preservation of resources through long use, extended use and recovery of products (Den Hollander et al., 2017, Bakker et al., 2014)), or slowing or closing the loop by advocating sufficiency, designing for disassembly, extending product lifetimes or facilitating access over ownership (Bocken et al., 2016). For the use phase, these design strategies will necessitate activities that users may not have previously been involved in, such as returning or reselling an item to the retailer or a third party rather than throwing it away, self-repairing products, purchasing something that has been pre-owned or remanufactured, renting rather purchasing items, or paying more for an item that will last longer – and then keeping and using it rather than buying a new one. When such behavioural aspects come into focus, it provides a rationale for addressing research that has focused on exactly this: design for sustainable behaviour, as it may provide complementary views to the more materials and business model oriented literature which dominates the academic circular economy literature.

Design for Sustainable Behaviour (DfSB) is a transdisciplinary research field, which aims to investigate, at various levels, how to influence the sustainability impact of consumers’ activities. Several dozen case studies can be found in literature (Daae and Boks, 2015). Almost without exception these focus on interaction with (new) products, such as choice of preferred washing machine programs (McCalley and Midden, 2002), switching off electrical appliances (Rodriguez and Boks, 2005), socially sustainable mobile phone use (Lilley, 2007), behaviour related to leaving the door of a refrigerator open too long (Elias, 2011), and sustainable use of wood stoves (Daae and Boks, 2016). DfSB literature has proposed a number of behavioural dimensions (Daae and Boks, 2014), strategies for design intervention (e.g. Lilley, 2009, Scott et al., 2012), and inspiration tools (Lockton et al., 2010, Daae and Boks, 2017) that may assist

designers in finding solutions towards sustainable behaviour. There has not yet been much attention in DfSB literature for applying tools and methods to behavioural challenges specifically related to fostering a circular economy. For instance, most case studies in the DfSB literature (many of which are mentioned in Daae and Boks (2015)) address behaviour related to energy, water, food or product efficiency, or in other words, to ‘using less’. The card deck tool “Design With Intent” (Lockton et al., 2010) presents 101 strategies for how designers may be able to influence behaviour using different ‘lenses’, each accompanied by an example, but only one of these (a waste bin) presents an example that can be directly related to a circular theme.

Several reasons may exist for this lack of attention. These types of behaviour may be seen as principally a yes or no decision (i.e. there are no increments like there are with using less), and therefore less interesting from an academic perspective. DfSB researchers may also avoid purchase or disposal behaviour because of a preference for focusing on the interaction during the use phase – which covers the core functionality of the product, and usually its main environmental impact. Themes related to design for a circular economy, such as design for reparability, upgradability, disassembly, remanufacturing, recycling etc. have been researched extensively in more traditional Design for Sustainability literature, but these fields have typically had a limited focus on the use phase (Boks and McAloone, 2009), and even less on user behaviour.

Research question and methodology

The above considerations provide the context for this paper, as they made us wonder to what extent DfSB strategies and tools may contribute in a circular economy context. Therefore we aim to map how design strategies that aim at affecting user behaviour towards circular economy goals are already applied on the market today. For this article, we make this concrete by addressing the following research question: *To what extent, and how, are dimensions of behaviour change already applied, intentionally or unintentionally, in the design or communication of product and services that contribute to a circular economy?* Answering this research question will contribute to a discussion on the applicability of DfSB strategies in the design and analysis of circular products and services. To simplify our analysis, we have chosen to represent the frameworks discussed in the introduction by four circular design or business strategies: reuse, recycling, maintenance/longevity and refurbishment, as these are commonly found when the concept of circular economy is presented (Ellen MacArthur Foundation, 2012, van Weelden et al., 2015, Piscicelli and Ludden, 2016).

Rather than extensively reviewing DfSB literature for design strategies, in this paper we have limited our analysis to one tool from DfSB literature in order to address these questions, and taken the Dimensions of Behaviour Change tool (DBC) as a starting point. The tool is based on nine main dimension categories (and 55 sub-dimensions) identified in Daae and Boks (2014) and aims to provide an overview of product and service characteristics that designers can influence to realise behaviour change. It also explains how different manifestations of these dimensions may influence user behaviour. These dimensions were the result of a combination of extensive workshops with both design professionals and students in Norway and the Netherlands, and efforts in translating results of social psychology research to a useful design tool. In the tool, the dimensions listed in Table 1 are presented as distinct categories of how designers may influence behaviour. We refer to Daae and Boks (2014) for a more elaborate description. The tool encompasses aspects of behaviour also addressed in other DfSB approaches, such as influence strategies by Tromp et al. (2011), Axis of Influence (Lilley, 2007) and Design with Intent (Lockton, 2010) and is therefore to some extent a representative choice for DfSB literature to analyse these aspects in a circular context.

Control	To what extent is the user or the product in control of the behaviour?
Obtrusiveness	How much attention does the behaviour design demand from the user? On a scale from obtrusive to unobtrusive.
Encouragement	To what extent does the design encourage desired behaviour or discourage undesired behaviour?
Meaning	How does the behaviour design motivate the desired behaviour, on a scale from emotional to rational.
Direction	Is the desired behaviour in line with, or opposing the wishes of the user?
Empathy	Is the behaviour design focusing on the user or on others/what others think?
Importance	How important or unimportant does the user consider the behaviour/consequence?
Timing	Does the user encounter the behaviour design before, during or after the behaviour?
Exposure	How frequently or rarely does the user encounter the behaviour design?

Table 1. Behavioural dimensions in the DBC tool.

To support our discussion we initially created a grid in which we placed examples of behavioural dimensions for each of them (see Figure 1). This gave us an opportunity to initially assess the relevance of the dimensions of behaviour change in a circular economy context, using the aforementioned strategies reuse, recycling, maintenance/longevity and refurbishment. We acknowledge that the ad-hoc identification of examples was a random but necessary process to collect data that would represent a more systematic coverage of examples that may exist. We have attempted to reduce the randomness by having three researchers independently explore their surroundings and the internet, each of them using their own approach and knowledge of ‘circular’ products and services. Open areas of the grid do not imply that there are no examples to fill these gaps, but merely that we did not find them in our investigations. This suggests that these areas probably represent less common applications of behavioural dimensions in a circular economy context.

We then analysed in more detail how four selected companies combine different DfSB strategies in the way they present their circular concepts on their websites. To that end, we paid specific attention to the case companies’ language and means of communication of their values and intentions with their consumers. All four companies focus on elements of one or more of the four circular strategies in their communication, but for the sake of the analysis we focus one the strategy in each of the companies which we judged to best represent its circular focus:

1. Patagonia Worn Wear: Reuse
2. Elvis & Kresse: Recycling
3. Tom Cridland: Maintenance/ longevity
4. Mud Jeans: Refurbishment

It is not our intention to assess sustainability contributions of the business models, but merely to assess which dimensions of behaviour change the companies use in the communications through their web sites. How the comparative analysis, which concludes the subsequent results section, was done, is explained in the paragraph in question.

Results and analysis

The following examples provide practical illustrations of the different dimensions of behaviour change for each of the four circular economy strategies (see also Figure 1). In the section below, each example in the figure is named and addressed briefly. Numbers in brackets refer to numbers in the figure. Relevant dimensions are highlighted in bold.

Maintenance and repair strategies

Examples related to maintenance and repair are relatively commonplace. The Fairphone (1) enables the user to replace broken parts on the phone and thus prolong the lifespan of the phone itself, which is an example of a **control** strategy. Car dashboards (2) indicate with an **obtrusive** warning when a car is due for a maintenance overhaul. The Norrøna flagship store in Oslo (3) has a service centre, where you can get your clothes fixed if you were looking for new, creating perfect **timing**. In many convenient locations (such as train stations), we are still **exposed** to shops that repair our old shoes (4). Patek Philippe Watches (5) market their products with the slogan “You never actually own a Patek Philippe. You merely look after it for the next generation”, providing **meaning**. Public advertisements point out the **importance** of repairing your products (6). Shops fixing broken glass on cell phones provide a service in the same **direction** as the user probably wants (7). On the web, there are multiple videos of how to fix things yourself (8), providing **encouragement** to users. The Restart project (9) organises social gatherings where you meet others and help each other repair electronics and household items. This can be regarded as an **empathy** strategy.

Reuse strategies

Similarly, it was relatively easy to find examples of design focused on people’s participation in reuse. Filippa K has second hand clothing stores in some of their shops, giving users **control** by enabling them to buy used clothes (10). Royal Dutch Shell give users the option to use their own favourite cups instead of giving away new cups when they enter a coffee subscription, **timing** it with the moment when they subscribe (12). Shpock is an online second-hand market with a very **obtrusive** marketing strategy (11). Second hand clothes stores have collection points spread out in many cities, **exposing** people to the concept of giving away the clothes they do not need (13). Finn.no, a major Norwegian online second hand store, published an estimate they had done of the reduced global warming impact their business had resulted in (14), giving **meaning** to it. Off-brand printer ink retailers often reuse original empty cartridges when they sell their products, providing a product in the **direction** people want (15). In some trains, there is a collection point where people are **encouraged** to leave newspapers for reuse (16). There are multiple apps and communities enabling members to help and share things and services (17), appealing to people’s **empathy**.

Refurbishment strategies

Refurbishment strategies that make use of the various dimensions of behaviour change were less easy to find. We also noted a thin line between refurbishment and reuse. A Swedish ketchup producer gives away sports caps that enable the user to repurpose empty ketchup bottles as water bottles (18). We would characterise this as a **control** strategy. Patagonia offers to refurbish worn Patagonia garments and marks them with a label (19), advertising for the concept in an un-**obtrusive** way. Freitag informs customers that the material in their product comes from truck-covers and thus gives **meaning** to them (20). “Sofagutta” refurbishes old high-quality couches and resells them (21). This is in line with many peoples demand and thus categorized as **direction**. Urban Upholstery refurbishes old furniture, leaving the frame exposed in order to **encourage** future refurbishment (22). In Japan, it is considered culturally valuable to repair something that is broken (23). People even use valuable materials such as gold in repairs and make them obvious; an example of using **empathy**.

Recycling strategies

We found it easiest to identify examples of use of behaviour change strategies in the context of recycling strategies, with all dimensions represented. This was not surprising as

recycling behaviour has received a lot of attention in the behaviour literature (e.g. Klöckner and Oppedal, 2011; Schultz et al., 1995).

Information on milk cartons that they can be recycled with plastic caps makes it easier for the users and provides them with **control** over their actions (24). Max, a Swedish burger chain has so many recycling fractions in their restaurant that it promotes recycling in an **obtrusive** way for the consumers (25). Firms such as HP provide return packaging for used toner cartridges upon purchase of new ones (26), an example of good **timing**. People are increasingly confronted with waste bins that provide the option for separating paper, bottles and general waste (27), which makes it more likely that they will participate in recycling behaviours. Municipalities that systematically offer such waste bins could be said to apply an **exposure** strategy. The Fun Theory concept of “bottle bank arcade” makes it fun to recycle (28) and is thus a **meaning** strategy. Garbage trucks in Oslo have “value transport” printed on them to remind people of the **importance** of recycling (29). Many cell-phone companies offer trade-in options of old cell phones (30). As this is in line with many customers’ wishes (to have a new phone and a discount), it is a **direction** strategy. Information about how to sort packaging **encourages** people to act upon it (31). Keep America Beautiful ensures that recyclable bottles address users in the first person, with the words “I want to be a bench. Recycle me”, which is an example of an **empathy** strategy (32).

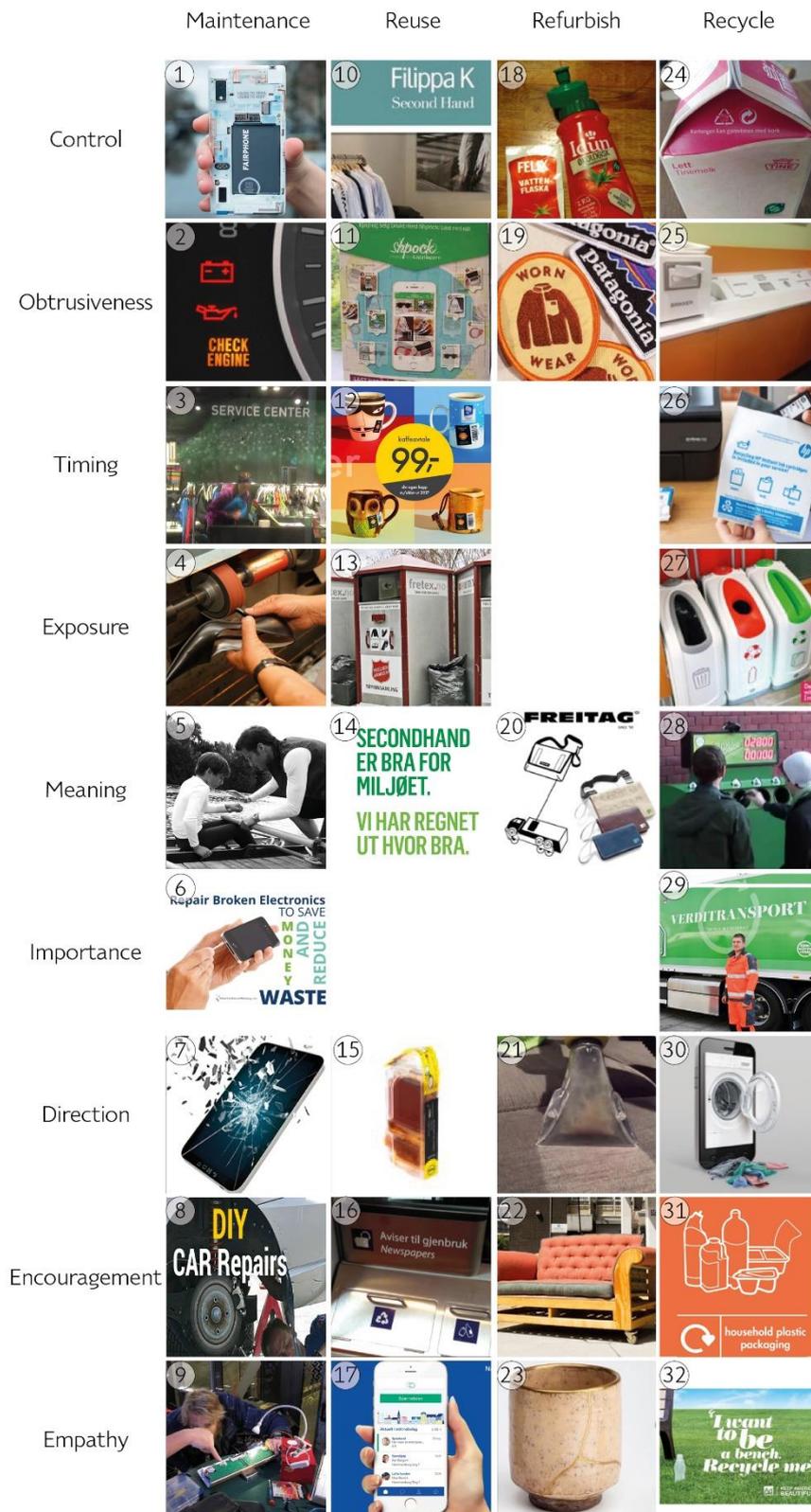


Figure 1. Grid of DfSB strategies related to CE. Explanations of the strategies are presented in the section above the figure.

From the above mapping and analysis, we observe that the majority of behaviour change dimensions can be found in ‘real life’ examples for most of the four circular economy goals. This is especially true for maintenance, recycling and reuse, whereas we found it more difficult to find examples for refurbishment strategies, which may be because refurbishment is not a widespread offering in business-to-consumer markets (Mugge et al., 2017). Moreover, it is worth noting that the behaviours actually required of consumers are often not ‘refurbishment’ or ‘recycling’ exactly (these processes normally are done by companies), but more ‘return’, ‘sort’ or ‘separate’, and therefore in a future study it may be necessary to adapt the circular economy goals accordingly. The circular model of leasing or sharing as a replacement for ownership is another topic for future exploration, and a focus on the growing Product Service Systems (PSS) and access-based consumption (e.g. Bardhi and Eckhardt, 2012) literature would provide a basis for this.

We also observed that in some instances, these examples address two or more of the dimensions (e.g. timing and exposure for the repair shops).

Case studies

Tom Cridland – Maintenance / longevity

Tom Cridland (TC) is a young entrepreneurial brand that audaciously prides itself on being the ‘world’s number 1 sustainable fashion brand’. Its signature promise guarantees the clothes for 30 years, with free repairs at any point during that time. The brand relies strongly on the lifestyle of its eponymous founder, who also runs a rock band and a successful PR agency, which has ensured the clothing business coverage in several significant global media outlets.

Control	The 30 year guarantee, including free repair and return postage, may seduce customers to purchase. It also enables the customer to use the product for a long time. However, the lack of systems to accommodate the repair guarantee, makes it harder for customers to take advantage of this.
Obtrusiveness	Marketing itself as ‘The world’s number 1 sustainable fashion brand’ is a bold and obtrusive, if unverified, statement, and TC certainly makes use of the ‘signature 30 year guarantee’ to advertise and sell the clothes through strong use of PR and media.
Encouragement	The 30 year guarantee encourages the customers to maintain their products for a long time.
Meaning	Although the brand provides emotional meaning by combining a story of celebrity, lifestyle and music to excite customers’ hedonism, it primarily communicates the rational aspects of long lasting products.
Direction	The brand is probably in line with both customers motivated by sustainability and by Cridland himself.
Empathy	The guarantee of 30 years’ free repairs focuses the customers’ attention mostly on themselves, as the value of durability will accrue to them. However, the brand’s strong emphasis on lifestyles and Cridlands’s personal story of a young, risk-taking entrepreneur challenging the global dominance of fast fashion, may also affects what others think of them.
Importance	The brand’s bold headline 30-year guarantee and ‘world’s number 1 sustainable brand’ claims increase the importance that longevity and durability will have for the consumer.
Timing	The 30-year guarantee prompts the customer before and at the point of sale. However, there is little evidence of how a customer should utilize the free repair; it may be that the labelling provides for this, but not having access to a garment it is difficult to say.
Exposure	How often costumers are exposed to the brand is strongly dependent on where they live and what news channels they follow.

Table 2: Dimensions of behaviour change for TC case

Patagonia Worn Wear – Reuse

Patagonia has identified itself as an environmentally conscious clothing company for decades. As a part of this, they promote the durability of their products, provide guides for maintenance and repair, and have a repair service. In addition to this, they enable customers to buy and sell worn, but fully functioning, Patagonia products. When selling worn products, the customer receives credit, which can be used to buy new or worn Patagonia garments.

Control	The concept enables the customer to buy and sell worn Patagonia garments. They leave the customer in complete control, but makes it easy by having fixed prices for different product categories when people trade in products, and display available worn products in an online store either as excellent, great or good condition. In addition, the reduced price of the worn wear makes it tempting for customers.
Obtrusiveness	The concept is relatively unobtrusive, apart from adding a “worn wear” label to the clothes sold as a worn Patagonia product. The “worn wear” web page is also relatively well hidden on the Patagonia web page, making it unobtrusive for customers who are unaware of it or do not search for it actively.
Encouragement	It can be said to both encourage buying second hand products and discourage keeping products that are not being used any more.
Meaning	Although they do argue that it is good for the environment to reuse products, their message is primarily playing on emotional values. They present testimonials of customers who have

	particular stories related to their products and they advocate that “scars tell a story” to make minor damages on the products into something positive.
Direction	This is highly in line with what the customers wish, as their target group most likely are people who, from an environmental or economic motivation, are attracted by the possibility to get money for garments they don’t use and buy second hand garments.
Empathy	The focus is both directed towards others and towards the customers themselves. The testimonials are told in a very personal perspective, but at the same time creates a feeling of a community. Also, their presentation of “Worn wear” as garments with a history, creates an interesting bridge between the customer who buys the product, and those who had it before.
Importance	The sustainability message will probably be considered important by the majority of potential customers.
Timing	The timing is primarily set to the moment of purchase, as the interaction happens in the web-shop or physical Patagonia store. A form of interaction also happens during the use phase, as the “worn wear” label on the products bought second hand is a constant reminder of the possibility to repair or sell the product back to Patagonia.
Exposure	The level of exposure depends on the area. Patagonia sells globally, but is more commonly used and advertised in some areas than in others. The worn wear has partly been promoted by a tour focusing on a few states in the US and a few select cities in Europe.

Table 3: Dimensions of behaviour change for Patagonia Worn Wear case

Mud Jeans – Refurbish

Mud Jeans is a clothing company that aims to reduce the environmental impact from the clothing industry. To achieve this, they do not only use ecological cotton and recycled materials, but also accommodates for circular economy by enabling leasing of clothes, pays refund for old Mud jeans when you buy a new pair, and sells refurbished clothes that either previously have been leasing garments or returned for refund. Leased or returned garments that are too damaged to be repaired and resold, are recycled and used as raw material for new garments.

Control	As customers choose to buy refurbished garments instead of new once, the concept leaves the user in control. However, significantly lower price suggests that Mud Jeans tries to persuade customers to buy used models rather than new ones.
Obtrusiveness	Their used garments have their own tab in the internet store, making this option relatively obvious to the user. The repaired garments are repaired in an obvious way rather than as invisible as possible. Neither example is very obtrusive, but easily visible at least.
Encouragement	The price and ease of access to buy refurbished clothes both encourage this behavior, but the possibility to return clothes discourages keeping garments that are not used.
Meaning	Mud Jeans argues rationally about the importance of reducing the impact from the clothing industry and the transition to a circular economy.
Direction	The possibilities of “selling” worn garments and of buying refurbished for a reduced price, is likely attractive to both environmentally and financially motivated customers.
Empathy	Mud Jeans only argues from an environmental perspective to promote the importance of refurbishment, and may thus be placed in the “others” end of this dimension’s spectrum.
Importance	Environmentally conscious customers will easily appreciate the importance of refurbished garments to prolong the lifespan.

Timing	The timing is primarily at moment of purchase, as both the possibility of buying refurbished garments and the information about refund, is available on the website one would visit if planning to buy a new garment. However, if having bought a refurbished garment, the obvious repairs may work as a reminder even after the purchase moment.
Exposure	This is not something most people are heavily exposed to. The information is on the website, but only available under the “about us” tab. The obvious repairs are easily seen, but does not communicate that it has been refurbished by the company itself.

Table 4: Dimensions of behaviour change for Mud Jeans case

Elvis & Kresse – recycling

Elvis and Kresse (E&K) is a successful social enterprise founded on sustainable principles. The business is built on rescuing and reclaiming materials that would otherwise go to waste, and turning these into high-end luxury products through design and handcrafting. 50% of profits go back to the fire fighters charity from where much of the material came, it has won awards for its entrepreneurial achievements, and the business is also creating partnerships with established luxury brands.

Control	By turning reclaimed materials into beautifully designed products E&K seduce the customer to make a purchase and simultaneously enables customers to buy products made by second hand materials. However, the price point is rather high, and thus the products will not be available to many customers.
Obtrusiveness	The products – especially those made from fire hose – have not had the raw materials disguised or sanitised. They are relatively obtrusively made from secondary materials, particularly those that display the original print from the hose.
Encouragement	Beautiful designs and a language of caring may encourage consumers to purchase. It also discourages the perception of such materials as waste.
Meaning	E&K’s story in which they ‘rescue’ old fire hoses, ‘transform’ them into beautiful, useful items and then ‘donate’ half their profits back to the firefighters’ charity gives emotional meaning to their brand and products.
Direction	The brand will probably be in line with both environmental concerned customers and for customers influenced by novelty or luxury.
Empathy	The E&K story thus mostly focuses on others, and the value that a purchase will bring to society and environment.
Importance	By turning unwanted materials into luxurious products through design, E&K increase the importance and value of these items. By presenting the story behind the materials, they increase the probable importance of them to the customers.
Timing	Their story is presented to the customer before and at the moment of purchase, and the customer is also reminded afterwards because of the special material.
Exposure	The brand has recently announced a partnership with the luxury brand Burberry, which will increase their exposure significantly. Their exposure is also enhanced by involvement with social media and charitable initiatives, and their status as a successful entrepreneurial brand.

Table 5: Dimensions of behaviour change for E&K case

Comparative analysis

Based on the previous descriptions, Table 6 aims to compare the presence of the dimensions of behaviour change in the design and communication of the products and services

Patagonia					
Mud Jeans					
E&K					
Meaning	Emotional	←—————→			Rational
TC					
Patagonia					
Mud Jeans					
E&K					
Direction	In line	←—————→			Opposing
TC					
Patagonia					
Mud Jeans					
E&K					
Empathy	Me	←—————→			Others
TC					
Patagonia					
Mud Jeans					
E&K					
Importance	Important	←—————→			Unimportant
TC					
Patagonia					
Mud Jeans					
E&K					
Timing	Before	←—————→		During	After
TC					
Patagonia					
Mud Jeans					
E&K					
Exposure	Rarely	←—————→			Frequently
TC					
Patagonia					
Mud Jeans					
E&K					

Table 6: Comparative Analysis

Meaning

Among the four companies, both extremes of the Meaning dimension can be observed. Some companies primarily communicate emotional aspects, whereas other companies rely on rational meaning. That said, all the companies focusing on emotional meaning do provide rational arguments why they are sustainable. This suggests that it is possible to tell a convincing story from both perspectives, and that it may be valuable to strongly rely on either end of the dimension, or use both for mutual reinforcement.

Direction

All the companies aim at being in line with the target group, offering the possibility for their customers to act in line with what they desire to do, as can be expected from any commercial company.

Empathy

All companies focus on other people than the customer, and two combine this with focus on the customer him/herself. This suggests that both strategies are worth considering when designing and communicating circular products and services.

Importance

All the companies highlight the circular aspects of their offering, thus making it important. It is natural for brands that focus on environmental messages to use these to promote their products.

Timing

The case companies studied use different strategies regarding the timing of the behavioural intervention. The two companies focusing on the user doing something after the purchase also have this represented more strongly in their communication than the brands that primarily wish to motivate the user to buy their products in the first place.

Exposure

How exposed the user is to the different companies is difficult to assess in general terms, as it is strongly dependent on how and where in the world the user is positioned compared to the company. Among the case companies, TC seems to strive most actively for achieving exposure and make it part of their business model.

Discussion

The initial mapping of random example in the grid presented in Figure 1, combined with the more focused comparative analysis presented in the previous sections suggests considerable variation in the way the dimensions of behaviour change manifest themselves in circular products and services. Direction, Importance and Control occur rather uniformly, whereas obtrusiveness, timing, exposure and empathy occur in different ways, making use of both extremes of the dimensions. We have identified several cases where use of both extremes actually reinforce each other. Another observation is that most, if not all, dimensions are to some extent recognizable in the companies' communications and therefore deserve consideration. This leaves designers with many different strategies to consider: which dimensions are most relevant, which dimensions can be combined, where to position the design within the different dimensions, and even how to combine different positions of the same dimension for the (communication of the) same product or service.

The research presented is limited in number of cases studies, and subject to subjective interpretations as to the level of each dimension considered present in each case. Therefore, we do not claim that our analysis provides more than an initial understanding of the potential of DfSB strategies for circular design. Neither do we claim that the presented examples reflect general tendencies for circular behaviour design, or that particular positions in some dimensions are more likely to be more successful than others in encouraging circular behaviours. Such claims would require more extensive, quantitative research, both in terms of number of companies studied, and more objective ways to determine the (degree of) presence of a dimension in a certain product or service, and in the communication thereof.

Nevertheless, we suggest that a 'dimensional analysis' could provide insights in a multitude of aspects related to the circular design. The DBC tool may provide support for circular designers and communication practitioners as it provides an overview of relevant dimensions that should or could be targeted when developing circular behaviour design. Going through the dimensions one by one and consciously addressing how a company wishes to

design and communicate its circular design will likely provide a more comprehensive picture than following a more intuitive approach, which may miss relevant opportunities for successful design and communication. In our opinion, such insights have not been discussed before in a similar systematic way and are not sufficiently recognized in the literature.

The overview presented in this study may therefore inspire researchers to take this idea further, and incorporate behavioural dimension thinking in the design of products and services as well as business models; the latter perspective is interesting as we see that the distinction between the product, the service and the business model that is being communicated, is often blurry.

In addition to the DBC tool, we assume that other tools and methodologies from the DfSB literature are also transferable to a circular economy context. If so, this opens up great opportunities for circular design researchers and practitioners to increase the likelihood of their designs being accepted by users, and of achieving the desired behaviour change. This may be especially relevant for more tricky or large-scale circular designs that are further away from the user's daily life, and therefore require more effort to change, such as buying reused clothes or electronics. To accommodate for such a transfer between the fields, it would be advantageous if additional studies and analysis were conducted, not only to investigate the potential to apply other DfSB tools in a circular context and recommend adjustments, but also to develop an overview of the DfSB tools that are likely to represent the greatest contribution to the circular context. It may also be worthwhile to consider an adaptation of the framework in such a way that it covers design and communication as separate items, but also in relation to each other.

Conclusion

In reviewing the application of DfSB strategies to a circular economy context we have seen how using such a framework may contribute to insights how to determine or improve a company's design and communication for a circular economy. We presented examples that show how design strategies can address circular economy challenges, and showed how four firms already, consciously or not, apply different combinations of DfSB strategies, using (combinations of) different behavioural dimensions to communicate their circular products and services. Together this provides an insightful picture of how DfSB dimensions can be applied in a circular context and used by firms as a checklist or toolbox, or to create new and innovative circular products and services and ways to communicate them. It is our intent to continue this research with further case studies, to support both further theoretical and prescriptive research.

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