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# The potential of Design for Behaviour Change to foster the transition to a circular economy

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**Abstract:** The negative environmental, social and economic effects of overconsumption and a throwaway culture have exposed the limits of traditional linear 'take-make-dispose' production and consumption patterns. Recently, the shift to a 'circular economy' has attracted growing interest as a possible pathway towards more sustainable ways of producing and consuming. Circular business models (e.g. product-service systems, hiring and leasing schemes, collaborative consumption, incentivised return and reuse) aim to keep resources in use for longer, extract maximum value from them whilst in use, and recover and regenerate products or components when they reach their end of life. However, these innovative propositions often encounter important corporate, regulatory and cultural barriers to their introduction. This paper discusses how Design for Behaviour Change (DfBC) – with a focus on Design for Sustainable Behaviour and Practice-oriented design – could contribute to address the latter and foster the transition to a circular economy.

**Keywords**: circular economy; consumer acceptance; design for behaviour change

## 1. Towards a circular economy

In recent decades, overconsumption and the rising demand for finite natural resources (e.g. raw materials, water, energy) have exerted growing pressure on the environment and produced increasing amounts of waste (Cohen, et al. 2010; European Commission 2011; Krausmann, et al. 2009; Tukker, et al. 2008). As a result, essential resources (e.g. rare earth metals critical to high-value manufacturing sectors such as aerospace, automotive and communications) have become scarce and more expensive, and their price volatility has negatively affected industry and the economy (Benton and Hazell 2013; European Commission 2011; Gregson, et al. 2015; Hislop and Hill 2011). With the global population expected to reach 9 billion in the next 35 years and the rising living standards in emerging economies (Bastein, et al. 2013; ESA 2013), it is estimated that in 2050 an equivalent of more than two planets would be needed to sustain human activity at the current rate of resource use (European Commission 2011).

Resource depletion and tighter environmental standards urgently call for more sustainable patterns of production and consumption able to decouple economic growth and sales revenues from scarce resource demand (Accenture 2014; Bastein, et al. 2013; Ellen MacArthur Foundation 2012). Transforming the economy onto a resource-efficient path is considered one of the greatest challenges of the 21st century (European Commission 2011; Wallace and Raingold 2012).

## *1.1 Linear vs circular economy*

Since the start of the industrial revolution, the economy has largely operated on a linear 'take-make-dispose' model of resource use (Ellen MacArthur Foundation 2012). This model relies on large quantities of easily accessible resources that are harvested or extracted by companies to manufacture products which are sold to consumers and discarded as waste when they are worn out or no longer needed (European Commission 2014c) (Figure 1). Based on the intensive (and often inefficient) use of raw materials, natural resources and energy, this traditional way of operating has proved to be at odds with constraints on the availability of virgin resources (Accenture 2014; Ellen MacArthur Foundation 2012).


*Figure 1 Linear economy.*

In recent years, the 'circular economy'– a multifaceted concept still lacking a scientifically endorsed definition – has gained increased traction as "an economy that provides multiple value creation mechanisms which are decoupled from the consumption of finite resources" (Ellen MacArthur Foundation and McKinsey Center for Business and Environment 2015, p.23). Building on McDonough and Braungart's (2002) idea of a 'cradle to cradle' system (as opposed to 'cradle to grave'), the Ellen MacArthur Foundation in partnership with the consultants McKinsey have advanced a 'butterfly model' of the circular economy (Figure 2) characterised by two types of materials flows: 'biological nutrients' (Figure 2, left), which are designed to re-enter the biosphere and build natural capital; and 'technical nutrients' (Figure 2, right), which are designed to circulate in closed loops without entering the biosphere (Ellen MacArthur Foundation 2012).

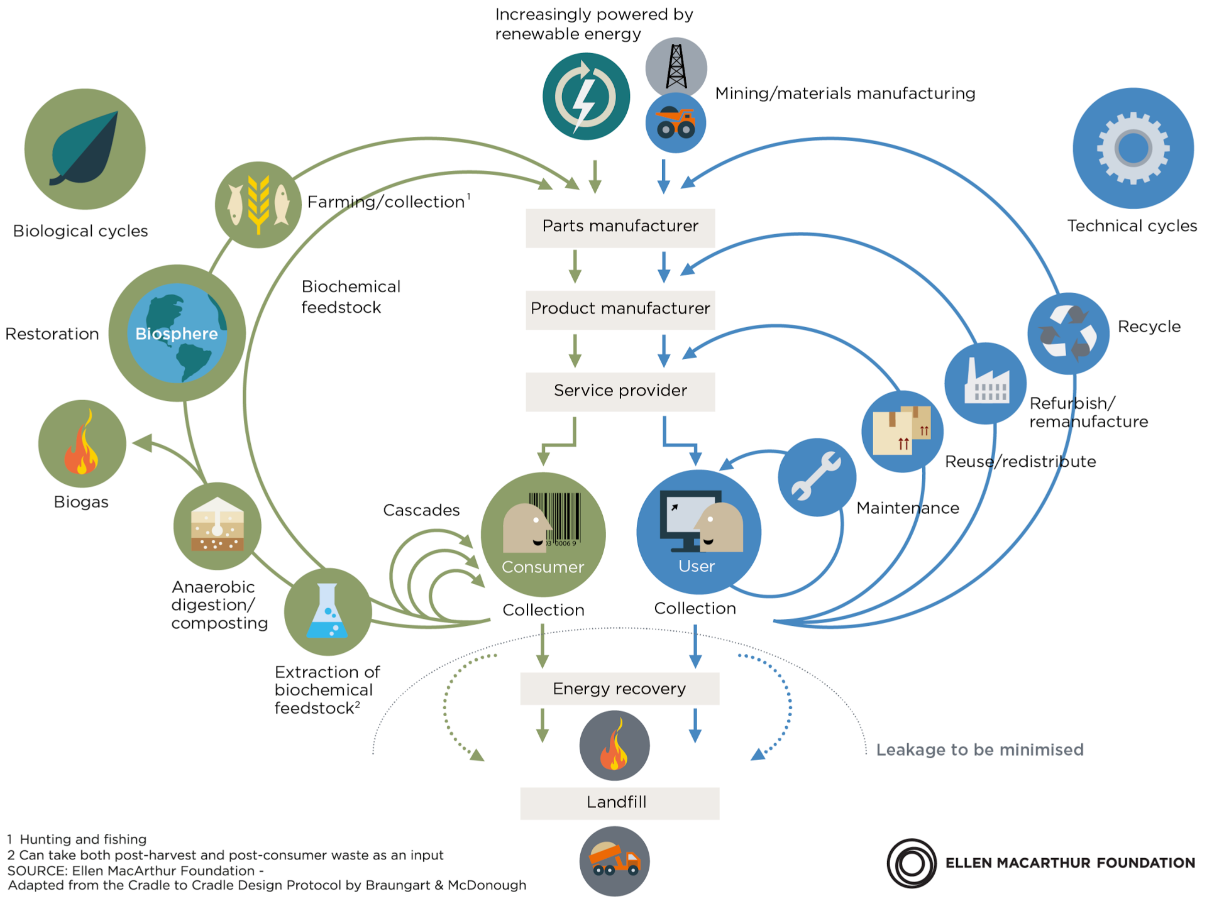


*Figure 2 The circular economy (Ellen MacArthur Foundation 2012, p.24). Reproduced with permission from the Ellen MacArthur Foundation.*

The value of biological nutrients, consisting of biomass and biotic waste streams, is maximised through biorefining processes that enable the 'extraction of biochemical feedstock' (e.g. fuels, materials and high-quality chemicals), although often in small volumes. The 'anaerobic digestion/composting' – a process in which micro-organisms break down organic material in the absence of oxygen – allows for the production of 'biogas' (methane) that can be used as an energy carrier, thereby contributing to energy supplies. Finally, biological nutrients can be returned to the soil as nutrients (i.e. 'restoration'), for example in the form of agricultural fertilisers (i.e. 'farming/collection') (Bastein, et al. 2013; Ellen MacArthur Foundation 2012).

Technical nutrients, consisting of manufactured products and materials, are first kept into circulation through their 'maintenance' and repair. Subsequently, it is possible to 'reuse/redistribute' them, e.g. through second-hand markets. The 'refurbish/remanufacture' loop involves repairing or replacing faulty components to return a product to good working conditions, or taking out failed parts of a used product and using them in a new one. These processes generally include quality controls to ensure the quality of the final product, which is often sold with a guarantee. Recycling (i.e. 'recycle') should be the final option at the end of the cascading use of technical nutrients, which makes it possible to recover materials contained in a product and put them back into other production processes (Bastein, et al. 2013; Ellen MacArthur Foundation 2012). Maintenance, reuse/redistribute and refurbish/remanufacture are preferred options compared to recycling since smaller inner loops retain the highest value. For example, a report from the Circular Economy Task Force – a government supported, business led group convened by Green Alliance in the UK – indicates that a reused iPhone retains around 48% of its value, the value of reusing its components is 28%, whereas its value as recyclate is just 0.24% of its original value (Benton and Hazell 2013).

A transition from a linear to a circular economy has the potential to benefit both the environment and the economy (Bakker, et al. 2014a; Ellen MacArthur Foundation and McKinsey Center for Business and Environment 2015; Gregson, et al. 2015; House of Commons 2014). From an environmental point of view, using 'waste' streams as a resource could provide secure and affordable supplies of raw materials, thus reducing the pressure on the environment connected with primary extraction, processing, production, transportation and disposal (Bastein, et al. 2013; Hislop and Hill 2011). This would also generate net savings for companies on material and energy costs, while reducing their dependency on resource markets and exposure to resource price volatility and supply risks (Accenture 2014; Wallace, et al. 2015). Apart from building resilience (both at a company and national level), a more circular economy can also provide opportunities for increased business competitiveness and profitability, while boosting employment (European Commission 2011).

In terms of economics, the Ellen MacArthur Foundation (2012) estimated that at European level the circular economy represents a material cost savings opportunity of between USD 380 and USD 630 billion per year. In the UK, materials savings of between £30-60 billion are expected to be achieved by adopting a circular approach to designing and using cars, vans, washing machines and mobile phones (Ellen MacArthur Foundation 2012). Bastein et al. (2013) estimated that the overall impact of moving towards a circular economy in the Netherlands would be €7.3 billion, involving the creation of approximately 54,000 jobs.

## *1.2 Circular business models*

A circular economy in which products have multiple lifecycles (i.e. the inner loops in Figure 2) requires business models based on longevity, reuse, repair, upgrade, refurbishment, renewability, capacity sharing and dematerialisation (Accenture 2014; Wallace, et al. 2015). Different authors have proposed various lists of 'circular business models' (also referred to as 'innovative' or 'resource efficient' business models). Table 1 compares the classifications adopted by Accenture (2014), Bakker et al. (2014b), Kiørboe et al. (2015) and REBUS (2015) by grouping them under the broad categories of 'product-based', 'service-based', 'sharing-based' and 'supply chain-based' circular business models.

*Table 1 Circular business models.*

| | Accenture 2014 | Bakker, et al. 2014b | Kiørboe, et al. 2015 | REBUS 2015 |
|---|---|---|---|---|
| PRODUCT-BASED | Product life extension<br>a. Resell<br>b. Repair/Upgrade<br>c. Remanufacture | Classic long life model | Product design | Long life |
| | | | Reuse | Incentivised return & re-use |
| | | | Repair | |
| | | Hybrid model | | |
| SERVICE-BASED | Product as a service | Performance model | Service- and function based models | Product Service System |
| | | | | Dematerialised services |
| | | Access model | | Hire & Leasing |
| SHARING-BASED | Sharing platforms | | Collaborative consumption | Collaborative consumption |
| SUPPLY CHAIN-BASED | | | | Made to order |
| | Circular supplies | | Recycling and waste management | |
| | Resource recovery<br>a. Re-/upcycle<br>b. Waste as a resource<br>c. Returning byproducts | | | Asset management |
| | | Gap exploiter model | | Collection of used products |

Product-based circular business models are built around high quality products designed to last (e.g. 'the classic long life model' in Bakker, et al. 2014b; 'product design' in Kiørboe, et al. 2015; 'long life' in REBUS 2015) and optimised for being later disassembled, remanufactured and reused (e.g. 'reuse' and 'repair' models in Kiørboe, et al. 2015). When these durable products are sold to the consumer (as opposed to being leased or rented, i.e. service-based circular business model), there are incentives or agreements in place to ensure that they are returned after use, collected, refurbished and sold for re-use on appropriate markets (e.g. 'product life extension' in Accenture 2014; 'incentivised return & reuse' in REBUS 2015) (Ellen MacArthur Foundation 2012). Durable products can also be combined with dedicated short-lived consumables (e.g. toner cartridges, coffee pads) whose repeat sale generates the primary revenue stream (e.g. 'the hybrid model' in Bakker, et al. 2014b).

In service-based circular business models the manufacturer or retailer retains the ownership of the product (in order to internalise the benefits of circular resource productivity) and acts as a service provider, thus selling the use of (or access to) the product for a limited period of time or a fixed amount of cycles rather than its one-way consumption (e.g. 'product as a service' in Accenture 2014; 'the access model' in Bakker, et al. 2014b; 'service- and function based models' in Kiørboe, et al. 2015; 'product service system' in REBUS 2015) (Ellen MacArthur Foundation 2012). When a product is leased or rented to the consumer and its ownership remains with the manufacturer or retailer (e.g. 'hire & leasing' in REBUS 2015), product durability, a longer service life, lower maintenance load, lower use of materials, ease of disassembly and refurbishment, and the existence of efficient and effective take-back systems become essential for the model to function. A second possibility is to provide a service offering the benefits of a product (i.e. delivering performance outputs), without the need for a physical product (e.g. 'performance model' in Bakker, et al. 2014b; 'dematerialised service' in REBUS 2015).

Sharing-based circular business models enable an increased utilisation rate of products by making possible their shared use, access or ownership (e.g. 'sharing platforms' in Accenture 2014; 'collaborative consumption' in Kiørboe, et al. 2015 and REBUS 2015). The rental of products between consumers (P2P) or between businesses (B2B) can generate an income for the product owner and provide cheaper access to a product for the renter. However, transactions can also be non-income based as in the case of P2P online and/or offline exchange and re-use (REBUS 2015).

Supply chain-based circular business models reduce the quantity of raw materials required to meet the market demand by recovering useful resources or energy out of disposed products and byproducts. This can be attained through internal collection, re-use, refurbishing and re-sale of used products (e.g. 'resource recovery' in Accenture 2014; 'asset management' in REBUS 2015) or through their recycling (e.g. 'circular supplies' in Accenture 2014; 'recycling and waste management' in Kiørboe, et al. 2015). Table 1 also considers REBUS's (2015) 'made to order' model – managing production as to minimise material requirements and producing only when demand is present, thus avoiding potential losses from over-stocking products – as a supply chain-based circular model.

The classification proposed in Table 1 does not allocate Bakker et al.'s (2014b) 'gap exploiter model' (i.e. models that exploit value gaps in the existing system, e.g. a person who repairs smartphones or sells second-hand equipment) and REBUS's (2015) 'collection of used products' (i.e. collection by a service provider to ensure products/materials are passed on to an appropriate re-use system) under any of the proposed macro-categories (i.e. product-, service-, sharing- and supply chain-based circular business models). The two business models could fall under any of the four categories.

## 2. Design for a circular economy

Design acts as both a barrier to and a catalyst for moving away from the current 'take-make-dispose' linear model to a circular economy (Wallace and Raingold 2012). Several authors (e.g. ESA 2013; RSA 2013; Wallace and Raingold 2012) report that approximately 80% of a product's environmental impact is 'locked in' at the design stage, when material choices are made and the durability of the product, its ease of reuse, disassembly, repair, upgradability, refurbishment and recycling is determined (European Environmental Bureau 2015).

Many products are currently designed and manufactured as to minimise production costs and stimulate their fast replacement. Moreover, their complexity makes effective and efficient recovery difficult or even impossible (Bastein, et al. 2013; Benton and Hazell 2013).

By contrast, in a circular economy products need to be designed for 'closed-loops', allowing for many life cycles and users while optimising the environmental effects of the materials employed (Accenture 2014). This means designing products to be used longer, reused, repaired, upgraded, remanufactured and eventually recycled (European Environmental Bureau 2015; Ellen MacArthur Foundation 2012; Hislop and Hill 2011; Wallace, et al. 2015). Furthermore, they need to be adapted to generate revenues not only at point of sale but also during use (e.g. through their maintenance, upgrade, or share) and be supported by low-cost return chain and reprocessing (Accenture 2014; Hislop and Hill 2011).

Currently, there are few studies that link design to a circular economy. The Great Recovery project – launched in 2012 in the UK by the Royal Society for the encouragement of Arts, Manufactures and Commerce (RSA) and the Technology Strategy Board (TSB) – aimed at specifically investigating the role of design in a circular economy. Four 'design models' were identified (Figure 3), which are directly associated with the different cycles proposed by the Ellen MacArthur Foundation's (2012) model (Table 2): (i) 'design for longevity' entails designing products that have a long lifespan, extended through their upgrade, fixing and repair; (ii) 'design for service' enables sharing and leasing arrangements, as well as product reuse and redistribution through digital platforms; (iii) 'design for re-use in manufacture' creates the conditions for product refurbishment and remanufacture; and (iv) 'design for material recovery' supports effective end-of-life material recoverability.

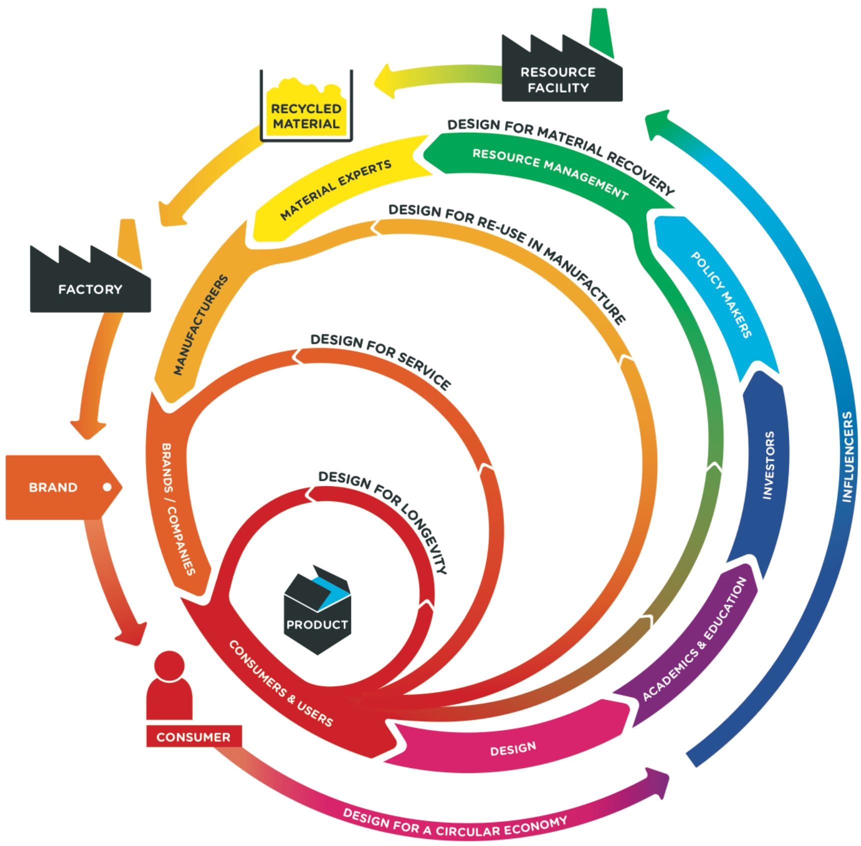


*Figure 3 Design for circularity diagram (RSA 2013, p.34). Reproduced with permission from the RSA.*

*Table 2 Circular economy loops and associated design strategies.*

| CIRCULAR ECONOMY LOOPS (Ellen MacArthur Foundation 2012) | DESIGN STRATEGIES (RSA 2013) |
|---|---|
| Maintenance | Design for longevity |
| Reuse/Redistribute | Design for service |
| Refurbish/Remanufacture | Design for re-use in manufacture |
| Recycle | Design for material recovery |

Bakker and colleagues (Bakker, et al. 2014a, 2014b) have conducted extensive research on how product design can address product life extension (through longer product life, refurbishment and remanufacturing) and product recycling in a circular economy. In their recently published book '*Products that last*', Bakker et al. (2014b) have proposed a methodology for applying circular business models and the following six 'design strategies for a long product lifespan' to products at different stages of their lifecycle (i.e. introduction, growth, maturity and decline):

- Design for attachment and trust
- Design for durability
- Design for standardisation and compatibility
- Design for ease of maintenance and repair
- Design for adaptability and upgradability
- Design for dis- and reassembly

## 3. The economic, political and cultural barriers to the circular economy

While a few attempts to implement circular business models and design approaches into (B2B or B2C) commercial propositions have been made (e.g. often cited examples include Philips's 'Pay-per-lux' model or Bundles's pay-per-use model for washing machines), these have not yet been implemented on a large scale and their uptake on the market is still very limited (Bastein, et al. 2013; Gregson, et al. 2015; Tukker 2015). There are significant economic, political and cultural barriers that need to be overcome for the circular economy to become mainstream (European Commission 2014c; Wallace and Raingold 2012).

### *3.1 Economic barriers*

From a business perspective, operating in a circular economy requires a significant change in business planning and strategy (Accenture 2014). Furthermore, companies shifting to a circular economy face economic challenges that range from the risk of cannibalisation (e.g. the introduction of a service-based proposition might have a negative impact on the sales performance of the company's product portfolio) to financial risk (e.g. leasing arrangements require manufacturers to make higher initial investments and financing of upfront production costs). In addition, a more widespread reuse of products is expected to lower the sales of new products, thus weakening business revenue and profits (Ellen MacArthur Foundation 2012; Wallace and Raingold 2012).

Nevertheless, a circular economy is largely portrayed as offering new business opportunities, strengthening competitiveness, generating employment (e.g. in the logistics services sector) and outweighing the costs in the long run (Accenture 2014; Bastein, et al. 2013; Ellen MacArthur Foundation 2012; Wallace and Raingold 2012).

## *3.2 Political barriers*

Many economic obstacles could be overcome by changing existing policies, rules and regulations (Wallace and Raingold 2012). Currently, natural resources are considered as "free" commodities and their economic value is not properly accounted for on the market (European Commission 2011). The low cost of virgin materials makes the use of recycled or reused parts less appealing for companies. Furthermore, rules and regulations in force tend to treat end-of-life products as 'waste to get rid of' rather than a resource (e.g. raw materials that can feed back in the production system) (Bastein, et al. 2013) and recyclate struggles to meet the quality standards demanded by the market for recycled products (Gregson, et al. 2015).

To avoid this, measures that are often advocated by proponents of a circular economy include the introduction of tax initiatives (e.g. shifting taxation from labour to resources; implementing tax premiums for the use of regenerated resources; reducing the rate of VAT on circular services such as repairs and reuse of components), setting recycling targets for industries, making companies responsible for products throughout their life cycle, and creating an international standard definition of waste (Accenture 2014; Bastein, et al. 2013).

## *3.3 Cultural barriers*

Cultural resistance could also prevent the implementation and uptake of circular business models in the market (Ellen MacArthur Foundation 2012). A circular economy requires a change in business practices as well as consumer behaviour (Ellen MacArthur Foundation and McKinsey Center for Business and Environment 2015). Leasing models, pay-per-use schemes, products with shared ownership and personalised maintenance or upgrade services depend upon a shift towards access over ownership and repair over repurchase (Gregson, et al. 2015; Wallace and Raingold 2012). Bastein et al. (2013) argue that consumers' craving for material possessions, their sensitivity to the latest fashion, the importance attributed to price (as opposed to, for example, looking at whether a product contains sustainable raw materials or it can be easily disassembled) and short-term considerations (e.g. looking at the price of a product rather than its entire lifecycle costs) are all possible barriers to moving towards a more circular economy.

While some authors (e.g. Ellen MacArthur Foundation 2012; Wallace and Raingold 2012) consider an on-going societal shift towards access rather than ownership (such as leasing mobile phones and car clubs) as a promising trend for the wider market penetration of circular business models, there is some consensus on the need for consumer acceptance to grow significantly to make circular economy a mainstream paradigm (European Commission 2014c; Wallace and Raingold 2012).

# 4. The untapped potential of designing for behaviour change

Research on design in the context of the circular economy has been largely limited to the identification of design strategies for circular business models, products and services (e.g. Bakker, et al. 2014a, 2014b; McDonough and Braungart 2002; RSA 2013). As the cultural barriers described above suggest, these often require consumers to change their behaviour. However, little attention has been devoted so far to the potential of Design for Behaviour Change (DfBC) to foster the transition from a linear to a circular economy. This section discusses how this emerging field of design research could account for behavioural factors and address consumer acceptance, thus contributing to the wider introduction and diffusion of circular business models, products and services in the market.

## *4.1 The (underexplored) consumer dimension in the circular economy*

Most available literature on the circular economy consists of reports produced by various organisations (e.g. Bastein, et al. 2013; Benton and Hazell 2013, 2014; Ellen MacArthur Foundation 2012; Hislop and Hill 2011; Wallace and Raingold 2012; Wallace, et al. 2015) and business consultancies (e.g. Accenture 2014; JWT 2014). These publications strive to make the business case for moving towards a circular economy, while governments support their cause by exploring what actions can be taken to facilitate the transition and remove existing regulatory hurdles (e.g. House of Commons 2014; European Commission 2011, 2014a, 2014b, 2014c; Kiørboe, et al. 2015; RLI 2015). So far the circular economy has been mainly portrayed “as an idealised producer-led model” to which academics tend to attribute inherent positive values by virtue of its possible contribution to sustainable development (*cf*. Gregson, et al. 2015, p.225). While this paper does not go into the merits of whether or not perfect resource circularity can be achieved (e.g. Gregson, et al. 2015; Moreno, et al. 2014) or the ethics of design for behaviour change (e.g. Lilley and Wilson 2013; Pettersen and Boks 2008), this section draws attention to how current discourse on the circular economy has tended to underestimate the role played by consumers in the transition from a linear to a circular economy.

The consumer dimension in the circular economy remains largely unexplored, which is at odds with the fact that most circular business models require (and rely on) a significant change in consumer behaviour and consumption patterns. How consumers view and interpret their role in a circular economy is as yet unclear (Bastein, et al. 2013) and different (if not contradicting) evidence and assumptions feature in the literature reviewed. For example, consumer acceptance is described as a major barrier to the transition towards a circular economy by Wallace and Raingold (2012), whereas it is expected to simply occur when circular business practice has reached a tipping point in the Ellen MacArthur Foundation’s (2012) report. Results of a study on the needs and concerns of citizens about the 'Biobased Economy' conducted by Tertium and the CSG Centre for Society and the Life Sciences in the Netherlands demonstrate how the matter of consumer acceptance of circular business models is a complex one and needs further investigation.

> "The circular economy seems to dovetail well with citizens' views of a biobased economy. Many believe that they should 'be more conscious about raw materials, recycling and reducing waste' (My 2030's, p.24). But product service systems are a different story. 'That is not true yet for a significant variation of the circular economy: "the lease society", in which consumers' belongings are all pretty much on loan instead of owned. ... This vision of the future evokes a fundamental discussion. A "lease society" is a desirable thing for some people, while for others it is an unrealistic and undesirable vision of the future'." (Bastein, et al. 2013, p.76)

A few empirical studies have recently attempted to fill this gap in knowledge by exploring consumer acceptance of PSSs (e.g. Antikainen, et al. 2015; Lidenhammar 2015) and refurbished products (e.g. van Weelden, et al. 2016). The latter, in particular, analysed the factors influencing consumer acceptance of refurbished mobile phones at each phase of the consumer decision-making process (i.e. pre-purchase, orientation, evaluation and post-purchase phase) and suggested some practical guidelines to increase consumer acceptance. The three-step approach proposed – 'attract', 'convince' and 'involve' – aims at purposefully changing consumer behaviour through design.

## *4.2 Design for behaviour change*

Design for Behaviour Change – an emerging field of design research and practice that focuses on the influence of design on human behaviour – has some untapped potential to be applied in the context of a circular economy. This section provides a brief overview of DfBC (for a literature review see Bhamra and Lilley 2015; Niedderer, et al. 2014; Wever 2012) and how it could contribute to a wider acceptance of circular business models.

DfBC draws from different theories in the behavioural and social sciences in order to understand human behaviour and how this can be changed by and through design in key areas such as sustainability, health and wellbeing, safety and social design. DfBC strategies and approaches are as diverse as the theories that inform them. Some theories address behaviour by looking at the cognition of the individual, others by accounting for the context in which the behaviour takes place, and others again mediate the middle ground between individual and contextual understandings of human behaviour (Niedderer, et al. 2014) (Figure 4).

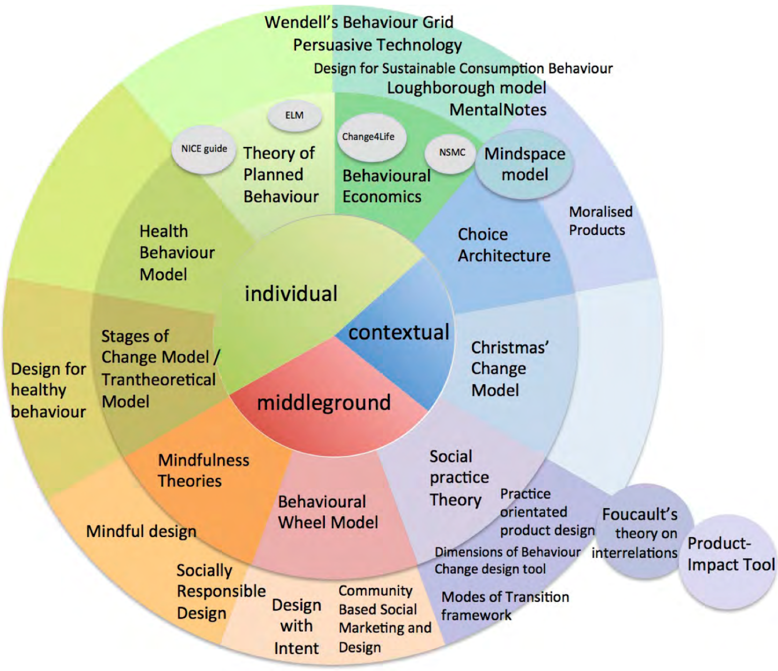


*Figure 4 Niedderer et al.'s (2014, p.52) categorisation of Design for Behaviour Change approaches in relation to behavioural theories. Reproduced with permission from Prof Kristina Niedderer.*

For example, the approach proposed by van Weelden et al. (2016) to increase consumer acceptance of refurbished products is informed by behavioural economics theories and falls under the category of Design for Sustainable Behaviour strategies (see also Lilley and Wilson 2013). Aimed at reducing the negative environmental and social impacts of products by moderating users' interaction with them, these strategies usually draw on mechanisms such as feedback, constraints and affordances as well as persuasive technology (i.e. technology that is intentionally designed to change a person's attitude or behaviour). However, the effectiveness of 'attract-convince-involve' interventions in practice still needs to be tested and it is not yet known whether they could also be applied to other circular business models (e.g. PSSs, collaborative consumption).

More generally, Design for Sustainable Behaviour approaches have been criticised by proponents of Practice-oriented design (informed by social practice theory) for:

- their focus on incremental savings that tend to disappear in larger trends (e.g. in the case of refurbished mobile phones, material savings achieved can be reduced or nullified by the trend of shortening lifespans of mobile phones);
- a risk of failing to achieve the intended behaviour change or even attaining opposite effects of those aimed for (e.g. higher acceptance of cheaper refurbished mobile phones could eventually increase the frequency and number of mobile phones purchased by an individual);
- a strong rhetoric of right and wrong behaviours that is present in the Design for Sustainable Behaviour literature (e.g. it is inherently assumed that buying a refurbished mobile phone is more desirable than buying a new one);

- a risk to miss opportunities on larger scales of change due to a focus on the individual consumer level (Kuijer and Bakker 2015).

Practice-oriented design is believed to overcome these limitations by looking at consumption as the result of more or less resource intensive social practices (e.g. eating, showering, driving) rather than individual consumer choice (Shove, et al. 2012). As such, opportunities for sustainable design arise from the possibility to modify or disrupt existing practices (as opposed to changing consumer behaviour) and establish new ones (Kuijer and de Jong 2012). This can be achieved by providing new material elements that can be integrated into novel practices (Kuijer and de Jong 2012) or challenging existing norms to create new ways of living and doing (Scott et al. 2012).

Practice-oriented design is still in its infancy and there are only a few examples of its application in empirical studies. Moreover, these studies do not directly address consumer acceptance of novel practices, which is paramount in the context of a circular economy to ensure that circular business models (and their associated practices) are well received by the market. A promising way to account for consumer acceptance in developing circular business models, products and services is to look at the two-way relationship between consumers and meanings (i.e. cultural conventions and social expectations) that underlie their associated practices (e.g. buying refurbished products, sharing, repairing). Preliminary research in this direction suggests that the dynamics of the relationship – mediated by individual values and perceptions of value (i.e. the perceived convenience and practicality of a certain behaviour/practice) – is able to explain acceptance (or rejection) of some types of circular business models (e.g. collaborative consumption) (see also Piscicelli, et al. 2015).

## 5. Conclusion: Setting the DfBC research agenda for a circular economy

The circular economy aims at decoupling growth from the pressure of production and consumption on world's finite resources and the environment (European Commission 2014a). The concept is gaining momentum and increasing recognition at international level, with the European Commission adopting it as part of both its resource efficiency and waste policy programmes (House of Commons 2014; European Commission 2011, 2014a, 2014b, 2014c). Based on the idea of eliminating waste from the industrial chain by creating 'closed-loops' through which resources can be recovered to generate value, the circular economy promises significant savings on production costs and less dependence on virgin materials and scarce resources, thus reducing companies' exposure to fluctuating commodity prices (House of Commons 2014).

There are, however, few examples of circular business models in the market. This is mainly due to the existence of outstanding economic, political and cultural barriers hindering the transition to a circular economy. This paper focussed on the latter and suggested that consumer acceptance could be addressed by integrating DfBC knowledge in the development of circular business models, products and services. Design for Sustainable

Behaviour and Practice-oriented design have been presented as two alternative approaches that could be applied in the context of the circular economy. The former offers insights on how to influence consumer decision making towards circular business models, whereas the latter has some untapped potential to address their consumer acceptance by capturing the interplay between individual values, perception of value and meanings underlying circular economy-related practices.

Despite the existing differences between Design for Sustainable Behaviour and Practice-oriented design, integrating DfBC (and their underpinning theories from the social sciences) in the design for a circular economy could ensure a better understanding of consumer behaviour and the enabling conditions for achieving a more widespread consumer acceptance of circular business models. In particular, it could offer valuable insights on how to stimulate demand for remanufactured goods, second-hand products and leasing arrangements, how to support the sharing of consumer products, and how to encourage repairing and maintenance activities that could help to extend the product lifespan.

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