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Designers as change agents in the Circular Economy

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Abstract

Several global reports have concluded that natural resource extraction at its current levels is unsustainable and will lead to the rapid erosion of the environment and tax global economic growth. One of the alternative paradigms to conserve those resources is the Circular Economy, a system driven by innovation that extends the utility of products as long as possible through a series of strategies that re-use resources. Design can act as a bridging tool and a catalyst for the innovation demanded by the Circular Economy because of its flexibility as a problem-solving discipline. The intermediary role of design can adapt to the complex requirements of Circular Economy stakeholders who want to shift their way of doing business to a more sustainable model, despite formidable policies, economic, cultural and political obstacles. The author explores the evolution and utility of design from a discipline that shapes objects to one that constructs and facilitates complex systems of interactions among collaborators, which in the Circular Economy includes consumers, manufacturers, logistics companies, governments, business and science entrepreneurs. Several examples of design's role in this facilitative process are presented that showcase the power of design to drive social and cultural transformations and re-cast industrial and business processes. Sustainable innovation is the centrepiece of the Circular Economy and design has a significant role to play in its adoption, particularly from a human-centred perspective that can address formidable constraints to its implementation.

Keywords: Circular Economy, Design-led innovation, Service design, Citizen designer, Sustainable innovation, Democratisation of design, Co-creation

Introduction – Why the Circular Economy?

The strain on natural resources in the world is borne out by alarming trends in unsustainable and accelerating resource extraction. The unwelcome by-products of these practices, which are predicted to double by 2050 (UN Environment International Resource Panel, 2019) have been global warming, air and water pollution and a throwaway consumer culture based on cheap credit and products with limited life cycles. The United Nations (UN) Environment International Resource Panel (2019) paints a dire picture of a global resource collapse unless Circular Economy practices are employed. Other reports such as the Circularity Gap Report (Circle Economy, 2019) and the Finnish Innovation Fund Report (Mead, 2018) also conclude that Circular Economy practices can help halve greenhouse gases by 2050 to meet targets agreed to by signatories to the Paris Climate Accord (United Nations, 2015). The 2030 Agenda for Sustainable Development (SDG, 2015) adopted by all United Nations Member States in 2015, lists responsible consumption and production and climate action as global priorities.

Circular Economy principles are also becoming more imperative during the COVID19 pandemic where global supply chain disruptions are slowing down manufacturing, food production, and forcing companies to re-think and reorganise their way of doing business. Circular Economy advocates see the pandemic fostering opportunities to help local communities source scarce resources like medical equipment, drinking water, and face masks through re-tooling of industrial production lines. Sustainability during the pandemic

requires re-thinking of whole systems of delivering goods and services given social distancing and supply chain disruptions (Blériot, 2020; Haigh & Bäunker, 2020).

The Circular Economy is part of a sustainable innovation paradigm which is seen as the "next generation of economic development thinking" in which the protection of the environment is coupled with the notion of business innovation (Saylor Academy, 2012). Reversing destructive natural resource consumption trends is the principle aim of the Circular Economy, a systematic re-framing of resource use based on biomimicry within closed-loop systems. The Circular Economy model draws on natural cycles where the re-uptake of decaying matter feeds the entire ecosystem (Ellen MacArthur Foundation, 2013); in a balanced ecosystem, nothing goes to waste. In the Circular Economy, waste in all its forms becomes a feedstock for new industrial processes, product development and energy production. The Circular Economy extends this idea to products and services through improved product design and moving waste to the top of the supply chain where it can be re-purposed and not dumped in landfills. The Circular Economy economic system shifts responsibility to achieve its goals to a diverse network of key players: end-users, manufactures, logistics companies, governments, and business and science entrepreneurs–who are interconnected and need to engage jointly in the complex undertaking to drive systemic change.

Designers have a key role to play in the system-wide economic changes driving the Circular Economy (Wastling, Charnley & Moreno, 2018) by facilitating the necessary transformations in human interactions, mindsets and relationships. Joore and Brezet (2015) argue that "change actors like designers play a strategic role in innovation and transition processes towards a sustainable society" (p. 92). Designers are already solving complex problems using human-centred approaches that are evidence-based and rely on various forms of user participation when designing for social change (Souleles, 2017). Robinson (2017) makes a strong case for a Social Circular Economy, where responsibility to help the socially disenfranchised, such as the homeless and unemployed, is part of the business landscape. Robinson (2017) sees design uniting "the circular economy and social enterprise concepts to deliver benefits for people, planet and profit" (p. 4). Haigh and Bäunker (2020) agree that designers can help a Circular Economy shape "a more resilient, socially just and environmentally safe world" (p. 1), however, the building of a socially responsible and environmentally sustainable economic system faces well known and formidable obstacles.

The roadblocks stopping the Circular Economy: Vision versus practicalities

For many years, researchers have explored Circular Economy concepts, such as Cradle-to-Cradle design, Regenerative Design, Laws of Ecology, Industrial Ecology, Biomimicry and the Blue Economy. Since 2010, the Ellen MacArthur Foundation (2013; https://www.ellenmacarthurfoundation.org/) has played a leading global role in unifying these concepts and promoting the Circular Economy model, designed to preserve the inherent value of products as long as is feasible (Lewandowski, 2016).

The central concept of the Circular Economy is re-using what is already there and exhausting its utility – a process that by necessity is driven by innovative thinking. Design acts as conceptual bridge between the exigencies of business and the drive to minimise waste using innovative methods. The Circular Economy's vocabulary reflects this paradigm shift with such terms as 'reverse logistics', 'reuse', 'remanufacture', 'extraction of biochemical feedstock, 'regeneration'. All of these terms derive their inspiration from the natural world, where creation and decay form part of a biological cycle that is balanced when healthy and generates waste that is re-incorporated into the ecosystem.

Productive use of waste in all its forms often requires disruptive, innovative practices throughout the value chain (Ritzéna & Sandström, 2017). However, there are substantial impediments to making this vision of an 'ecologically' balanced economy a reality, chief among them are financial incentives for companies, particularly in manufacturing, to change their way of doing business to fit a circular model. Operational logistics have to be restructured in the Circular Economy and attitudes have to shift to accept that investing in circular practices will help companies maintain a profit. Technological barriers also have to be overcome as well as policy challenges prompted by shifts in global politics (IMSA Amsterdam, 2013; Ritzéna & Sandström, 2017; Van Eijk, 2015).

There are also significant policy framework barriers experienced by all countries in which governments are not incentivizing businesses and scientist entrepreneurs through tax breaks, grants and significant seed money investment (De Jesus & Mendonça, 2018; Kirchherr et al., 2018; Van Eijk, 2015). Existing policies may inhibit businesses that want to adopt Circular Economy practices (R2π, 2018). Current events amply demonstrate this reality, particularly with developed nations offshoring mixed recycling for processing which is no longer a viable option. China has initiated a new policy rejecting shipments of mixed recycled waste from overseas that does not meet its stringent contamination thresholds. The crackdown has created an economic crisis among the developed world's recycling businesses (Cole, 2017; Parker, 2018). Countries such as the Philippines and Malaysia have also rejected overseas shipments of recycled waste from Canada and Australia (Denyer, 2019). Some forward-thinking waste managers are now actively searching for industrial processes that can, for example, convert recycled glass into sand for use in roadbeds (Fleischmann, 2019).

The attitude barrier

In a wide-ranging survey among stakeholders and sustainable development experts in the European Union (EU), respondents identified 'cultural barriers' as the major impediment to Circular Economy implementation (Kirchherr et al., 2018). 'Cultural barriers' were identified as low consumer interest and awareness of Circular Economy practices and companies hesitant to collaborate in the value chain because of low virgin material prices, high upfront investment, and regulatory obstructions and limited funding. A lack of urgency and strategic company planning using hard data about the Circular Economy's benefits were also cited as obstacles. The authors also suggest that further Research and Development (R&D) funding will not guarantee the Circular Economy's success in the EU. This finding is supported by Boer (2005), who predicted it is risky to invest in environmental technologies that customers do not want and which governments are unwilling to support. Other authors acknowledge that shifting to a Circular Economy is as much about the shifting mindset of people, as it is about technological innovation (Adrodegari, Pashou & Saccani, 2017; Prendeville & Bocken, 2017; Teso & Walters, 2016).

Geographic barriers also impede Circular Economy practices (Fleischmann, 2019). Many Circular Economy initiatives are centred in metropolitan areas with high population densities and high innovation indices which attract government funding. Regional areas are often geographically isolated, have smaller populations and lower innovation indices. In these areas, Circular Economy initiatives face a lack of funding and expertise (Fleischmann, 2019) and an often 'risk-averse' attitude by businesses and regional governments (Coronado, Acosta & Ferñandez, 2008). Ironically, according to Van Eijk (2015), local governments can drive policy changes much faster. Van Eijk estimates the period for the implementation of regulatory changes on an international level takes about a decade; in the EU policy changes happen in five years and on the local level it takes about a year.

With all these formidable obstacles it would seem the prospects for widespread adoption of the Circular Economy is ultimately unachievable. It is at this point where design can prove its efficacy by helping shift cultural resistance to engagement with the Circular Economy and by providing the innovative business framework for making it a reality. There are ample examples of how designers can drive these critical transitions to a Circular Economy which follows the trajectory of how design has evolved to meet social needs.

From product to service design: The changing role of design in servitisation and business model innovation

Design as a discipline has undergone tremendous changes over the past 30 years from being a mere form giving or styling activity to "being able to influence a company's entire business strategy" (Gardien & Gilsing, 2013, p. 56). Design's aesthetic function has evolved into a tool to focus on people and technology (user-experience design); as a differentiation tool to support branding; as a business tool for fuelling innovation; and finally as a cultural tool enabling transformation (Gardien & Gilsing, 2013; Hernández, Cooper, Tether & Murphy, 2018). Activist designers have also been early adopters of the sustainability discourse initiated through the seminal work of Victor Papanek with his book "Design for the Real World: Human Ecology and Social Change" published in 1971. Since the 1980s, these environmental designers have been instrumental thinkers and practitioners in the green design and eco-design movements.

Although designers have been involved in a systematic approach to reducing environmental impact through green product design, the emotional or behavioural dimension such as user-product attachment has largely been ignored by manufacturers (Ceschin & Gaziulusoy, 2016) – a finding which has a direct bearing on 'cultural resistance' to the Circular Economy. Years before the Circular Economy gained currency as a systematic model, Van Nes and Cramer (2005) found that 78% of products still function when they are replaced, evidence of the throwaway economy. Products are often discarded due to changing user preference and change in fashion (Cooper, 2006). The current so-called 'linear economy' is producing products with a limited shelf life often achieved through built-in obsolescence. A prominent example is the electronic waste created by the purchase of new versions of the same product like mobile phones or smart appliances made obsolete by software upgrades that do not work on older products. Despite growing secondary markets for purchasing used mobile phones such as the iPhone, the consumer-driven economy demands product life spans that are limited and have been decreasing (European Environment Agency, 2017). Van Nes and Cramer (2005) summed up the disposable product problem this way: "This requires the development of dynamic and flexible products, which implies designing for variability and product attachment and preparing the product for future repair or upgrading". Lewandowski (2016) describes this way forward as a holistic approach where products are designed within an ecosystem of carefully managed and re-used resources where product afterlife is part of the equation. In this system, waste is minimized through extended product lifespans in a closed material loop of multiple users rather than individual consumers. As a result, toxic and polluting materials are better controlled (De los Rios & Charnley, 2017).

There are many examples where product designers are already taking a more holistic approach and designing out waste by increasingly using modular design to lengthen product lifespans (European Environment Agency, 2017). A good example of modular production is Fairphone (https://www.fairphone.com/en/), an entrepreneurial European company employing modular product design to break the cycle of consumers buying new mobile phones every time a new model comes out

(Figure 1). The Amsterdam-based mobile phone manufacturer subscribes to the idea that consumers will opt for mobile phones that are designed to last up to five years, are virtually unbreakable, and can be updated with simple modular replacements that consumers can do themselves. Fairphone employs Circular Economy principles of creating smartphones that can be maintained, repaired and upgraded by end-users, are more robust and last much longer than the average smartphone. Next to the modular design, the systems thinking approach extends to ethically sourced materials and supply chains. The self-repair and maintenance of the phone through owners using basic tools and online available repair tutorials (Mestre & Cooper, 2017) are one of the main drivers for increasing product longevity. Fairphone advertises, "if you cannot open it you do not own it".

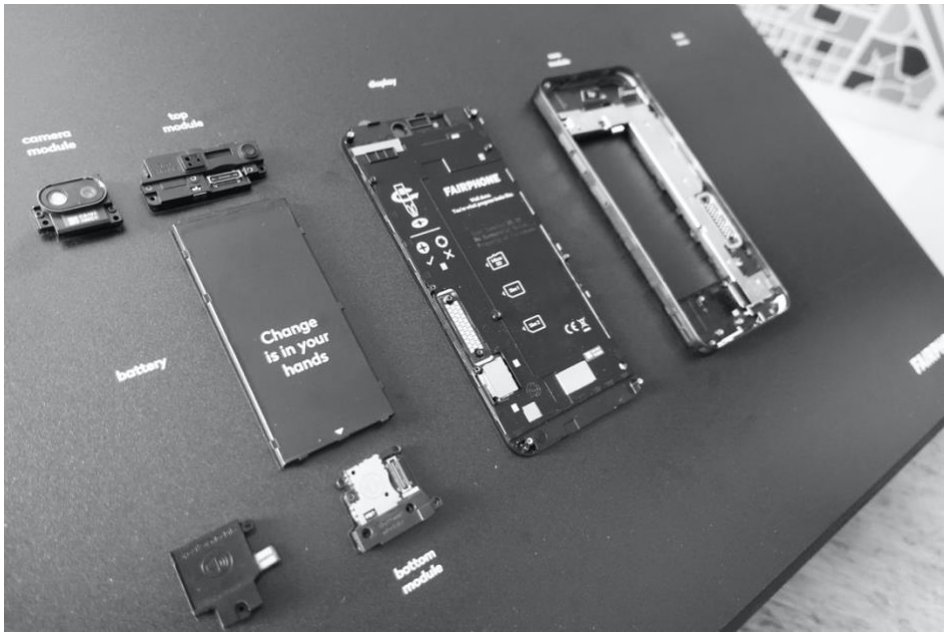


Figure 1: Modular Design Fairphone 3, Source (Creative Commons 4.0). https://en.m.wikipedia.org/wiki/File:Fairphone_3_modules_on_display.jpg.

As Fairphone illustrates, business models are no longer following a linear path. Disruption and digital technology are re-inventing the way consumers participate in economic activities.

Designers are also helping businesses re-define new models of ownership and use. Several authors have suggested that designers can influence business and consumer behaviour and thus meet Circular Economy goals. This is clearly illustrated in the concept of servitisation or Product Service Systems (PSS), where a product is not bought but essentially leased from a producer who maintains it. The PSS concept can apply to anything from office space, to clothing to lighting systems and vehicles.

Rather than re-design an entire production and distribution system, servitisation allows smaller businesses to take the first steps toward engaging the Circular Economy without having to make significant financial investments (Michelini, et al., 2017; Spring & Araujo, 2017). In particular, the Internet of Things (IoT) has lowered the barriers of engagement in circular business model innovation by using technology such as sensors, apps and integrated logistics to redefine the relationship between consumers, products and manufacturers (Spring & Araujo, 2017). Various circular business models are making use of the IoT, especially services as part of the sharing economy like car and bike-sharing (e.g. Bycyclen in Copenhagen,

CitiBike in New York, Mobike in China). Companies such as Lime, which advertises “Micromobility for all” offers electric scooters in congested urban environments and has essentially monetised transportation using phone apps linked to credit cards.

Designers are now involved in developing such service ideas around products which include a “network of actors who produce, deliver and manage the PSS [Product Service System]” (Ceschin & Gaziulusoy, 2016, p. 131). One well-known example of this innovative business model is Pay-per-Lux, where Phillips offers light as a service (ARUP, 2016). The way it works is that companies receive a state-of-the-art smart lighting system with no upfront investment. The customer then pays only for the light that is used. Phillips will update the light system when out of date and will retrieve the original system for secondary use elsewhere.

The automotive industry is also experimenting with innovative, circular business models. Electric car manufacturer Riversimple (https://www.riversimple.com/) is pioneering 'next-generation' electric vehicles by basing its company pricing on an expansive leasing model which includes insurance, repair and maintenance (Ceschin & Gaziulusoy, 2016). In these comprehensive leasing models, the consumer does not ‘own’ the vehicle; Riversimple pays for all the ancillary services motivating the company to design an electric vehicle with minimal energy usage requiring fewer repairs and thus increasing the car’s lifespan. This comprehensive leasing model is an alternative to manufacturers’ dependence on consumers purchasing new model vehicles. Many other well-known companies are trialling the ‘access economy’ or so-called ‘on-demand economy’. For example, IKEA has just announced plans to rent out furniture instead of selling its do-it-yourself flat box products (Pownall, 2019). Smaller businesses like Rype Office has moved beyond the trialling phase and offers three furniture options for customers for lease or purchase that include new, re-made or refreshed furniture with buy-back guarantees (Ellen MacArthur Foundation, 2017b; Rype Office Furniture, n.d.).

Designers are also creating more circular electronic products by creating a service based on user behaviour. Gerrad Street (https://gerrardst.nl/), a Dutch company, is combining a modular design with servitisation. Two alumni from Delft University in the Netherlands, started the company using the concept of servistising a modular design of headphones which they provide to customers on a subscription basis (Looijs, 2017). The business model theoretically creates a cheaper and more sustainable product. In this model, customers pay to use the headphones on a monthly or yearly basis, which entitles them to upgrades and repairs. “The design of their products is modular and no glue is used so they are easy to disassemble, repair or add new hardware” (Ellen MacArthur Foundation, 2017c). Gerrard Street leases its headphones for less than 10£ per month, which for many users is an attractive financial alternative to buying expensive headphones on the open market.

These examples of applying Circular Economy principles to product design clearly illustrate ideas of holistic innovation by creating mass consumer products as a service rather than an owned object with limited utility. Modular design with interchangeable parts that consumers can swap out creates a closed resource loop product system that maximises resources rather than limiting their use. Designers are now engaging in extending product lifetime through durable design and design for maintenance as well as increasing utilisation through sharing schemes or PSS.

Human-centred design for a Circular Economy: The critical role of design-led innovation

The manufacturing process is being re-defined by smart product design, which is one aspect of the Circular Economy. It is an example of design's innovative capacity. The Cox review commissioned in 2005 in the United Kingdom (UK) was the first to articulate clearly that Design is what links creativity and innovation in industry (HM Treasury, 2005). "Design has many different definitions, but at its heart, it is about the process of translating ideas into reality, making abstract thoughts tangible and concrete" (HM Treasury, 2005, p. 3). The International Council Societies of Industrial Design (ICSID) describes design as:

> "…a creative activity whose aim is to establish the multifaceted qualities of objects, processes, services and their systems in whole life cycles. Therefore, design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange." (DRP, 2013)

The transformational role of design has not been lost on policymakers in many countries. Having identified design and designers as major influential contributors to economies (e.g. Design Council, 2011; DMI, 2015; DesignSingapore Council, 2009) has led to an increase in government-funded support for design-driven innovation programs in countries such as the UK, Denmark and Finland. Countries like Singapore went even further and developed a structured design culture through policy-driven design-led innovation to tackle innovation challenges and economic development. Government driven design support programmes have also powered regional innovation and introduced design-led research methods to non-designers, researchers, businesses and educators (Gulari, Melioranski, Er & Fremantle, 2017).

Design-led innovation: The nuts and bolts

At its heart, design-led innovation is a human-centred process which makes use of real-time research through user engagement, collaboration and co-creation. Design-led innovation is "generally considered whole systems approach providing the ability to combine empathy for the context of a problem, creativity in the generation of insights and solutions, and rationality to analyse and fit solutions to the context" (Alexander, 2013). The core principle of design-led innovation as a solutions-based system starts by investigating and tracking the end-users, their motivations and requirements. Designers spend time with users of products or services to gauge what they want and to discover unarticulated needs through observation, interviewing, video or photo-ethnography, and customer journey mapping. The findings and developed insights are shared with the stakeholders offering the product or service. The creative process of generating new ideas is done collaboratively by integrating various stakeholder perspectives and then prototyping and trialling ideas in an iterative process to come up with the most effective solutions. "Design-led innovation offers methods to drive required business model transformation and is recognized as one of the key enablers in the transition to a Circular Economy" (Fleischmann, 2019, p. 382).

A well-known application of design-led innovation is Design Thinking which has been globally adopted in the business world to drive radical innovation, create competitive advantage and change business culture and behaviour (Brown, 2009; Vianna, et al., 2014). Design Thinking and other design-led innovation methods can be applied at a strategic, service, product or on an organisational level by facilitating a design-driven culture to change the mindsets of employees and customers (Kilian, Sarrazin & Yeon, 2015; Matthews, Townsen & Wrigley, 2016). Designers offer an organic process that allows ideas to rapidly bubble up to the surface, be tested, and then moulded. In very important ways, design-led innovation is a catalyst for ideation between stakeholders along the value chain.

As Aminoff, Valkokari and Kettunen (2016) argue, the transition to a Circular Economy "cannot be achieved if individual organizations advance their own interest independently...[it] requires new value chain partners, or new roles of existing partners and a new kind of collaboration between the participating partners" (p. 629). Designers can help to approach problems from a human-centred perspective and design methods are being used to better understand customers through a collaborative process (Fraser, 2010; Storvang, Jensen, Christensen & Storgaard, 2013).

Examples of design-led innovation are starting to appear in the old economy, state-run businesses such as the postal service in Australia. Collaboration is at the heart of an Australia Post initiative that has identified the Circular Economy as a way to become a better corporate citizen and implement Circular Economy strategies. More importantly, Australia Post (2017) is recognising the role design plays in the process: "…you cannot be at arm's-length in the Circular Economy. It is a co-designed system based on synergies and building connections" (p. 4). Concretely, Australia Post cites its collaboration with Nespresso, the coffee capsule company and a recycling plant in Nowra, New South Wales, Australia to illustrate the re-use/recycling loop in the Circular Economy. Nespresso customers can order a pre-paid Australia Post satchel online or at a Nespresso store and mail up to 130 capsules to the recycling plant where the coffee grounds are composted and the aluminium capsules are made into other products – part of the 're-use' closed loop system advocated by the Circular Economy.

While Australia Post illustrates the technical loop of Circular Economy logistics, the EU is incorporating design-led innovation into the value chain of the Circular Economy by fostering multidisciplinary scientific collaboration – part of the biological loop. The EU has been at the forefront of making scientific advancements, particularly in chemistry, an integral part of 'upcycling' in the Circular Economy. Upcycling is a concept where used materials are converted into something of greater or equal value (LoopedWorks, 2015). Central to this effort is catalysis, a chemical process that has widespread industrial applications in reducing waste on a large scale. Examples of the use of 'green' catalytic processes in the Circular Economy context are plentiful in a laboratory setting but there has been little large-scale commercialisation of the processes that are reducing waste and creating new value. As discussed, the reasons for impediments to commercialisation have largely revolved around business scepticism. While the pathways to commercial success are not as straightforward as chemical conversions, the commercialisation phase of catalytic development is benefitting from design-led collaboration, ideation, prototyping and scalability which can map various approaches involving all stakeholders in the process.

A company already practicing design-led innovation as a path to large scale commercialisation and moving Circular Economy practices beyond the prototype stages is Bolt Threads (2019), a bio-design company in the U.S. The bioeconomy company unifies science with business and design when using biotechnology to develop and promote consumer goods. The company bases its consumer products on engineered yeast to produce a spider silk protein which is spun into yarn and marketed as fast fashion. Bolt Thread focuses "on the consumer in the messaging and design of its products" (Ginsberg & Chieza, 2019, p. 4) and is a good example of a start-up with the potential to scale up its production while having a reduced environmental footprint, a primary Circular Economy goal. Designers also help the company to overcome "a widespread public aversion to genetically modified organisms" (Ginsberg & Chieza, 2019, p. 4) through a design-led innovation process that brings science and business interests together. This unifying characteristic of the design process is clearly producing results in business innovation.

Helping stakeholders to move forward: Circular Economy toolkits

Understanding the Circular Economy and how to make it work within a business or governmental context presents formidable challenges. Bringing so many diverse groups together is being facilitated by Circular Economy 'toolkits' which designers use to help stakeholders map the processes involved in designing Circular Economy initiatives. Toolkits, like those offered by the Ellen MacArthur Foundation and the design consultancy IDEO, reveal the key steps needed to implement Circular Economy principles (Ellen MacArthur Foundation, 2015, 2017a; The Circular Design Guide, 2017). The Circular Economy toolkits are a relatively new way to address social and economic complexities using a process of interviewing, mapping, iterating solutions, and tools for recording results.

Toolkits have a variety of ways of translating the Circular Economy's new vocabulary into meaningful metrics and graphics that illuminate critical components of the Circular Economy closed loop value-chain of product design and service innovation. Toolkits also employ step-by-step methods for selecting stakeholders and increasing their participation in ideation. Some toolkits focus on generating data that helps companies decide on the most sustainable way to source raw materials by comparing 'circularity' of individual products as well as evaluating company-level circularity. Still, others suggest financial models encourage entrepreneurial Circular Economy start-ups (e.g. Evans, et al., 2013; Zero Waste, 2016).

There are currently various open-source Circular Economy toolkits available for companies and policymakers wanting to learn more about how to implement Circular Economy practices. However, there is limited research into the effectiveness of the design and use of these toolkits. Simonchick et al. (2015) highlight that "the choice of a specific toolkit (both visual representation tools and user-research techniques) is highly situation-dependent (e.g. level of access to customer's organization, level of initial insight, time limitations and the needed level of detail etc.)" (p. 8) hence selecting the appropriate toolkit can already influence the level of success. Reigado et al. (2017) explored the Circular Design Guide developed by Ellen MacArthur Foundation and IDEO as an alternative to improve the application of product-service-systems methodologies; the researchers reported the toolkit's strength lies in the process of understanding the problem context and stakeholder engagement, however, the Circular Design Guide lacks practical aspects such as identifying the competitors.

As more toolkits are offered to help implement the Circular Economy, a key question remains underexplored: How effective are the tools inside the toolkit when compared to standard business practices such as due diligence, benchmarking and market scans? It is difficult to measure design's innovation outcomes and quantify how a company's design culture contributes to innovation, including Circular Economy toolkits. Work needs to be done to analyse the effectiveness of these toolkits from a design-led innovation standpoint.

The citizen designer: Co-creating a sustainable future

Consumers are key stakeholders in achieving the Circular Economy vision. The role of the citizen designer was foreshadowed by Lipson and Kurman (2010) who wrote "we will witness a growing amount of consumer-led product development and modification across a wide range of industries that manufacture physical objects" (p. 55). Opportunities for user-customized products have increasingly emerged over the past decade. Shoe and sportswear manufacturers such as Converse, Nike, Adidas and Puma allow their customers to customize products through the use of online services. Customers can influence the final design of their shoes by selecting colours for the outsole, sole or laces and can further personalise their

product by adding a name or a flag (in case of Adidas). Some car manufacturers such as Toyota or VW leave the final stages of design to their customers through an online configuration tool. Customers can configure their car to their needs and unique tastes and ultimately can buy a more satisfying product. This kind of participation in the creation process has seen its latest manifestation in crowdsourcing innovations (Howe, 2006; Lipson & Kurman, 2010). Companies or organisations post creative briefs or challenges on the Internet seeking input or solutions from their customers, employees, partners or the wider community (Hammon, & Hippner, 2012; Libert, Spector & Tapscott, 2008; Maher, Paulini & Murty, 2010). This "open-source dialogue" invites the wisdom of crowds to "collective design" and the customer/citizen being able to influence the outcome and drive change (Duffy & Partners, 2008; Maher, Paulini & Murty, 2010).

Participatory design as a strategic business tool to develop better products, improve brand communication or services has been utilized in the business world for many years. It is best known for involving customers to participate in value-creating activities, such as user-testing products or prototypes to develop new or improved products. Crowdsourcing and co-creation are two newer participatory practices which give a voice to the user and wider public who can add valuable feedback to Circular Economy practices from a public angle. On a large scale, the City of Glasgow, for example, aims to globally crowdsource Circular Economy innovations and wants to implement the winning solutions that the online challenge generates (University of Strathclyde, 2019).

Co-creation, broadly defined as "any act of collective creativity, i.e. creativity that is shared by two or more people" (Sanders & Stappers, 2008, p. 6), differs from crowdsourcing as it allows the end-user or customer to become *actively* involved and an *equal partner* in the creation process (Bason, 2010; Sanders & Stappers, 2008). Therefore, the people who benefit from a service, product or process to be developed or improved are actively participating in the creation process and receive expert status in the creative team (Sanders & Stappers, 2008). Co-creation "is the difference between people creating a great idea for you and people working with you to make a good idea great" (Williams, 2013).

Co-creation has become increasingly popular in the social and public innovation sectors to address complex, global problems from a sustainable perspective (Bason, 2010; European Commission, 2013; Mahy & Zahedi, 2010). Co-creation is seen by many as a central factor of a Circular Economy (Leube & Walcher, 2017) because the "social value of co-creation is fuelled by aspirations for the longer term, humanistic, and more sustainable ways of living" (Sanders & Simons, 2009). Fablabs, for example, provide fruitful ground for shifting the responsibility of creation to the citizen or community groups (Fleischmann, Hielscher & Merritt, 2016). The community-based digital fabrication workshops are often run voluntarily and can generally be freely accessed by the wider public. Ideas and initiatives for change can therefore emerge from the bottom-up and can lead to grassroots innovations – thus being more aligned with the needs of the community (Chilvers & Longhurst, 2013; Seyfang & Smith, 2013). Fablabs can facilitate a creation process that is opposed to the usual top-down approach leading to what Hippel (2005) sees as democratizing innovation.

Although Fablabs have been criticised for non-sustainable practices (Brown, 2015; Fleischmann, Hielscher & Merritt, 2016) – as part of community-based production such as repair cafes and hacker and maker spaces – they are perceived as convergent with the Circular Economy (Ede, 2016). For example, The Great Recovery (2016) project which looked at the Circular Economy from a designer's perspective (2012-2016) used a Fablab to encourage re-use by fixing objects like a broken handle with 3D printing technology

instead of buying a new product. Here the community-based production challenges the planned obsolescence of products through the 'right to repair' credo. Fablabs are also seen as "hotspots for Arduino and sensor technology development, and circular thinking needs this to help unlock the data flows that accompany our products" (The Great Recovery, 2016, p. 29). The Fab City in Barcelona which is seen as "building bridges for circular networks of fabrication" (Sicar, 2018, p. 18) recently opened up a Fab Market to promote distributed manufacturing "where designers can fabricate for low cost and sell their open-source designs globally" (Ede, 2016, p. 10). This new way of production follows a paradigm of 'design global, manufacture local' which "means the 'light' things (bits, information, shared/open source design) travel, but the 'heavy' things (atoms, the physical, manufacturing) stay local" (Ede, 2016, p. 10).

Distributed manufacturing systems, such as Fab Labs, are one way to challenge the mass manufacturing system in a linear economy. These new disruptive business models shorten manufacturing supply chains and are based on low volume, on-demand and bespoke manufacturing. These disruptive models incorporate new modes of interactions via customer-led designs. One such company is Disrupt Sports (2018) which offers bespoke designed sports gear. Customers design their surfboard, skateboard or snowboard. The motto of Disrupt Sports is: "You design, we create, you shred". As a result, instead of producing hundreds of similar surfboards, that may or may not sell, Disrupt Sports produces on-demand, customized products aligned to customer's specifications which guarantee sales and at the same time saves resources instead of manufacturing solely based on marketing.

The democratisation of Design (Fleischmann, 2015), is an important agent in the transition to a Circular Economy. The rise of the prosumer (proactive consumer) and citizen designer is central to the collaborative design process in the Circular Economy. The democratisation of design gives people an agency in making the Circular Economy work. Critics of this process, however, fear "the blurring of the boundaries between amateur and professional design practice" (Massanari, 2012). Advocates see the advantages in co-creation or the user-centred design participation process and welcome the "'open-source' dialogue that invites the audience into the creative process" (Duffy & Partners, 2008). Tim Brown, CEO of IDEO has famously declared "Design is everywhere, inevitably everyone is a designer…" (Brown, 2014). Not everyone agrees; Treder (2015), for example, defines the citizen designer more concretely as a "design participant" – he argues, perhaps everyone is a designer… but not everyone should design.

Conclusion: Future trends

As a discipline, design is a catalyst for change. Designers have always used a flexible, iterative approach to problem-solving, which is an instrumental process in re-imagining the future. The Circular Economy posits a paradigm of a more sustainable world that saves natural resources using nature's ecosystems as a roadmap. The Circular Economy envisions a complete re-ordering of economic and social priorities designed to preserve the world's dwindling natural resources, increase product longevity, reduce waste and phase out the endless cycle of cheap consumer credit fuelling non-stop consumption. There are still formidable policy and economic obstacles blocking the path of this radical transition to a circular way of doing business. Designers and citizen designers as change agents can help remove those obstacles and accelerate the transition to a Circular Economy. However, it is often difficult to communicate the value of design to stakeholders because of intangible qualities such as facilitating collaboration and strategic planning (Bletcher, 2017). There is a lack of understanding about the expansive role designers can take in the transformation to the Circular Economy (Bletcher, 2017).

Tonkinwise (2015) argues that designers are futurists because they deal in fiction, speculation, provocation and discourse — all elements of successful design practices. It is these disruptive traits that allow designers to shape the way we live and how we act, fundamental to the changes the Circular Economy demands of its stakeholders. New Design disciplines, such as Transition Design, incorporate these futurist qualities demanded by the Circular Economy. As an emergent way of addressing large-scale problems, practitioners of Transition Design play a key role in re-framing global problems (Irwin, 2015). The social impact of large-scale changes, such as reducing reliance on fossil fuels for energy, is part of the transitional designers' toolkit. Irwin (2015) argues that Transitional Design is dynamic and by its very nature open-ended and speculative which results in a circular, iterative problem-solving approach.

Designers have taken on a variety of crucial roles which are demanded by the Circular Economy: product designers encourage collaboration and co-creation between experts and amateurs to re-define product life cycles and respond to end-user needs; transition designers are facilitators between key stakeholders; fiction designers re-imagine our future and its possibilities; designers marry technology with logistics; and graphic designers help the world visualise the way to a sustainable future by mapping relationships, information and data.

All these design roles use systems thinking that lies at the heart of the Circular Economy where current patterns of consumption and production are supplanted by sustainable business models such as servitisation and modular products that are leased instead of owned. Time in this leased world becomes a commodity while manufacturers can focus on sustainable product production. These transitions do not happen in a vacuum but require consumers to take ownership of changes with designers leading the discourse. In the Circular Economy, designers become co-creators in designing with the people. Designers adapt their roles to encompass citizen participation in the iterative process.

As Fleischmann (2015) predicted, "the democratisation of design will not go away but will allow more 'non-designers' to become involved in idea generation, development and production of products, services or processes" (p. 103). In the Circular Economy, non-designers are crucial to its large-scale adoption. Approaching social challenges and complex problems such as creating a sustainable future has seen the empowerment of the end-user, citizen or community group by engaging them in the problem-solving process. Designers can unify stakeholders, including the public, governmental agencies, and the business and scientific communities in a common vision that can realise the goals of the Circular Economy. Educators must also adopt a leading role in training the new generation of designers who will have the future tools, creativity and vision to construct the Circular Economy.

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