7 Circular Design for a Transition to a Sustainable Circular Society: Defining a New Profession

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1 Introduction

In recent years, there has been increasing global enthusiasm for circular economy (CE) as the approach of choice for businesses, industries, and governments to achieve continued economic growth and overcome the challenge of decoupling growth from resource use (D'Amato et al. 2017; Ellen MacArthur Foundation 2013; Fletcher and Rammelt 2017; Ward et al. 2016). The CE model builds on a history of ideas about minimising resource use on an ecologically bounded 'spaceship earth' (Boulding 1966; Crocker 2018), through cradle-to-cradle product design (McDonough and Braungart 2010), a performance economy[1] based around services rather than ownership (Stahel 2010) and other CE and sustainability strategies (Haas et al. 2020; Korhonen, Nuur, et al. 2018; Reike et al. 2018; Stahel 2020; Winans et al. 2017).

Governments have translated circular enthusiasm into national strategies and roadmaps, albeit with varying scope and intent (Asia-Pacific Economic Cooperation 2020; Circular Economy Initiative Deutschland 2021; Poulton and Lyne 2009; Price Waterhouse Cooper 2019; Schandl et al. 2021). CE narratives offer an appealing rationale for business opportunity and green growth in an era of net zero

[1] In fact, Stahel (2020) distinguishes a circular economy and performance economy in that only the latter is a consistent systematic implementation of the former idea.

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ambitions (Black et al. 2021; Corvellec et al. 2021; Haucke 2018; Saidani et al. 2017; Temesgen et al. 2019). Despite the enthusiasm, consumption-based evaluation of global circular implementation, based on material footprint (e.g. Wiedmann et al. 2015), shows static or declining progress over the last five years (Platform for Accelerating the Circular Economy (PACE) 2020).[2] Reasons for this gap between circular rhetoric and a reality of negative material and emission feedback are multiple, including excessive reliance on waste and recycling (Valenzuela and Böhm 2017; Vonk 2018), offshoring of material footprint (Horvath et al. 2019; Wiedmann et al. 2015), and many other issues. Hence, there are calls to move beyond the mainstream model, including with respect to circular design (Moreno et al. 2016; Schroeder et al. 2019).

CE strategies, especially recycling (Allwood 2014; Islam and Huda 2019), appear to encourage rather than discourage increased consumption, resource use and emissions, through the so-called rebound effect (Figge and Thorpe 2019; Hobson 2021; Makov and Vivanco 2018; Zink and Geyer 2017), and the false belief that recycling infrastructure and processes are effective (Binet et al. 2019). More generally, circularity is promoted in an era where dominant energy sources remain fossil fuel-based (Corvellec et al. 2021; Jackson and Victor 2020; Kothari et al. 2014; Twomey and Washington 2016). The diversity of definitions and implementations included under the broad umbrella of CE has also been criticised, particularly with respect to increasing greenwashing potential (Corvellec et al. 2021; Figge and Thorpe 2019; Geissdoerfer et al. 2017; Holzinger 2020; Homrich et al. 2018; Kirchherr et al. 2017; Korhonen, Honkasalo, et al. 2018; Makov and Vivanco 2018; Reike et al. 2018; Temesgen et al. 2019). These and other reasons, suggests that circularity for circularity's sake (Harris et al. 2021) rather than a sustainable transition is being promoted.

The differences between the green growth narrative of circular economy (Hickel and Kallis 2020; Wanner 2015), and environmental, social and economic progress towards sustainable development have become increasingly apparent (Alonso-Almeida et al. 2020; Blum et al. 2020; Camilleri 2018; Corona et al. 2019; Desing et al. 2020; Haupt and Hellweg 2019; Johansson and Henriksson 2020; Reike et al. 2018; Schroeder et al. 2019; Velenturf and Jopson 2019; WEF 2020; Whalen and Whalen 2020). In an effort to rescue the impetus of circularity, reconnect this to sustainability, and distinguish modest reform from a circular transformation (Reike et al. 2018), a movement driven by the goal of enabling a circular society is becoming popular (Fan et al. 2019; Jaeger-Erben et al. 2021; Kayikci et al. 2021; Leipold et al. 2021; Melles 2021; Ralph Boch et al. 2020; van der Velden 2021; Velenturf and Jopson 2019; Velenturf and Purnell 2021; Wu et al. 2022). This transformist movement is supported by a holistic circular discourse with closer

[2] The Circularity Gap project measures progress using material footprint indexes (MFI) data, including proxies where necessary, for a consumption account of progress that for a nation as a whole and the materials required to support specific lifestyles.

links to sustainable development considerations (Bauwens et al. 2020; Calisto Friant et al. 2020a, b; De Angelis and Ianulardo 2020; Melles et al. 2022; Twomey and Washington 2016; van den Bergh 2020). Building on an earlier definition of a resource-circulating society (Komiyama and Takeuchi 2006), the circular society vision and the sustainable circular economy principles driving this are becoming the preferred term for a range of stakeholders looking beyond the mainstream narrative.[3]

2 A Plurality of Circular Discourses

The mainstream circular economy narrative is not the only circular discourse on offer. Several scholars with political economy lenses have examined the emergence of any conflict between different accounts of circularity and also the existence within the circular economy of hybrid mixes of narratives. Referring to their work on CE discursive differences as an outcome of their work on the UK Resource Recovery from Waste programme (RRfW), Velenturf and Purnell (2021) identified a continuum 'from resource efficiency, improving existing practices, and weak sustainability on the one hand … to resource productivity and strong sustainability on the other hand, requiring radical changes to resource use in our society' (2021, 1443). Ortega-Alvarado et al. (2021) founded a range of competing discourses about waste, consumption and sharing economy under the banner of circularity in Norway, while Johanssen and Henriksson (2020) founded weak and strong circularity discourses reminiscent of the circular economy and society distinction. For Australia, Melles (2021) finds mainstream and more holistic circular discourses competing to define the transition in that country, while Friant et al. (2022) articulate a similar account for the Netherlands of circular discourses varying between technocentric and transformational.

To address weaknesses in representing the full range of systemic economic, materials, energy and other challenges to a sustainable CE, Friant et al. (Calisto Friant et al. 2020a, b) develop a typology of circularity discourses,[4] particularly focussed on the contrast between mainstream CE and a circular society account. A central difference is that a reform of capitalism and new economic thinking, respect for ecological boundaries and prosperity for all through social innovation and new business models is necessary for circular society. Thus, Doughnut Economics (Raworth 2017), which argues for an economy based on market, household, government and commons within ecological limits, is a circular society position. Thus, the circular society agenda of socio-political and economic change and vision integrates and expands on the CE focus on material efficiencies and relevant business models.

[3] See this Dutch consortium https://ewuu.nl/en/research/circular-society/.

[4] Discourses are narratives that circulate and justify practices (Hardy and Thomas 2015).

3 Circular Discourses and Design

Everyone designs who devises courses of action aimed at changing existing situations into preferred ones (Simon 1996).

The mainstream technicist and holistic circular society discourses offer different opportunities for a sustainable circular economy and design. As noted above, mainstream CE identifies one of its main strategies as designing out waste and pollution (EMF 2015), and industrial and product design strategies are often proposed to include recycled content and waste, as well as adopting eco-efficiency approaches. However, sustainable circular design principles (below) ask us to avoid waste altogether rather than designing it by treating waste and standard recycling as inevitable inputs, and there is far greater scope for design practices with respect to circular society goals (Ralph Boch et al. 2020). This has been recognised by some scholars who have suggested that circular design should expand its remit beyond mainstream industrial and product design considerations (e.g. Moreno et al. 2016). In the following paragraphs, we give a brief excursion into the expanding role of design and compare narrow and broader conceptions of circular design. This is a prelude to presenting sustainable CE principles as the basis for a new definition of sustainable circular design.

An early critique of the unsustainability of expert industrial design was the work of Viktor Papanek—Design for the Real World (Papanek 1971). Responses to Papanek's criticism gave rise over time to the development of social design and the engagement of design in development (e.g. Kumar et al. 2016) and equity issues across the globe (Melles et al. 2011). As a result, design methods and processes, including co-design as part of the new landscapes of design (Sanders and Stappers 2008), have diffused into many social and sustainability domains (Boylston 2019). Thus, in addition to designing out waste and pollution in an industrial and business context, design can be deployed in designing social and political futures (Earley 2017; Fry 2009; Hales 2013; Wastling et al. 2018).

For circular economy, design has been increasingly highlighted as a catalyst (Andrews 2015; Moreno et al. 2016; van Dam et al. 2020). Firstly, existing discussion and materials on circular design include a diverse array of well-known eco-design methods and principles, e.g. design for manufacture, life-cycle analysis (LCA), cradle to and thinking, cradle to cradle design (McDonough and Braungart 2010), and design for recycling, etc. (den Hollander et al. 2017). A good example of the new synthesis is the Circular Design Guide[5]—a joint initiative of EMF and IDEO design agency. Current discussions of circular design typically include deliberations on the circular design of product service systems (Halstenberg and Stark 2019) and business models (Saidani et al. 2017). In addition, proposals for a new circular design curriculum will build on existing practices and knowledge from design for sustainability (Moreno et al. 2016).

[5] Methods (circulardesignguide.com).

Secondly, circular design within circular economy narratives sometimes extends its operational boundary to help define circular business models, including product service systems (McAloone and Pigosso 2018). Hence, there is a need to implement a design for product and service integrity agenda, through employing all the so-called R-strategies from refuse to recycle (den Hollander et al. 2017; McAloone and Pigosso 2018). Other proposals also identify a range of new communicative, e.g. storytelling and strategic competencies for circular design that extend into diffuse design space (Sumter et al. 2020). Thus, an expanded role for industrial design practices to influence production, consumption, policy and education has been proposed recently (van Dam et al. 2020). Hence, this wider sphere of influence already suggests an expanded definition of circular design is the order of the day.

Indeed, policy, regulation, standards and multiple other mechanisms and actors must create an environment in which mainstream industrial design practices would make sense and in turn reinforce a sustainability transition (Allwood 2014; EEA 2019). Thus, circular design discussions occasionally allude to broader societal, economic, and environmental aspects (Bocken et al. 2016; Lofthouse and Prendeville 2018; Moreno et al. 2016). Other more holistic accounts of circular design focussed on its human-centred potential (Lofthouse and Prendeville 2018) offer some guidance on principles and knowledge requirements. This application of more diffuse design thinking and practices is consistent with design for social innovation (Kumar et al. 2016; Manzini 2015), social business models (Burkett 2013), policy design (Howlett 2020; Huybrechts et al. 2017) and systems based social design (Boylston 2019).

Thus, beyond a circular economy vision of technology innovation, a more diffuse circular design focuses on multi-stakeholder strategic re-design of new institutions for a sustainable circular society (Goodin 1996; Hobday et al. 2012; Huybrechts et al. 2017; Ralph Boch et al. 2020). Such an agenda expands the remit of design from technical to social innovation and from narrow industrial design expertise to more diffuse design inputs to social change, as Manzini (2015) has identified. Our chapter takes this agenda up and links it to sustainable circular economy principles as well as the circular society discourse and agenda.

4 Multi-stakeholder and Multi-level Sustainable Circular Design Principles

A systems account of the interactions between social and technical innovation and multi-stakeholder institutional reform is required to explain how sustainability transitions can happen. Systems thinking is one of the overarching principles in this transition, and places emphasis on identifying the feedback and interactions among the variables in the systems (Meadows 2008; Sterman 2000), for example, how circular economy activities lead to a rebound in production outputs (Zink and Geyer 2017) or how recycling may ‘surprisingly’ increase consumption (Fitch-Roy

et al. 2019). Principles are also required to strategically influence this transition, as articulated in multi-level sustainability transitions theory (Loorbach et al. 2017).

Multi-level transitions theory (MLP) meanwhile envisions the change process towards a new socio-technical regime—a circular society or *only* a circular economy—as the product of multi-stakeholder and multi-level innovations in policy and practice (Geels 2011; Kanda et al. 2020; Loorbach et al. 2017; Rauschmayer et al. 2015). Consistent with such an approach, we require a set of principles that can encourage the multi-level technical and socio-economic and political changes to encourage a just transition to a circular society. Below, we suggest sustainable circular economy principles and offer a detailed breakdown of the interdependent strategies needed to achieve this transition.

Velenturf and Purnell (2021) outline a set of ten principles that highlight how to mobilise communities private sector, and the government to develop circular society solutions for specific contexts. Acknowledging sustainable development concerns, it is a model that combines circular economy and society discourses and considerations (Calisto Friant et al. 2020a, b; D'Amato et al. 2017; Jaeger-Erben et al. 2021: Reike et al. 2018). The framework provides scope for broad ranging technical and social innovation through private, public and civic sectors. Their circular design outline (principle 3) argues for far more than the usual re-design of products; products and the materials that they are made of are embedded in supply chains, wider systems of production and consumption, society and the environment. This is calling for a system-wide transformation of industrial systems and society, consistent with the industrial ecology thesis but also beyond (Saavedra et al. 2018). The example (principle 3) of their design for circularity outline illustrates the holistic scope of their proposal.

> Design, select and transform industrial systems, supply chains, materials and products, using "R-ladders" and whole-system assessments of solutions to optimise stocks and the degree of closing loops of resource flows, minimising raw material extraction and waste generation, optimising value generated for people, and enabling reintegration of materials into natural biogeochemical processes at end-of-use, through continuous processes nurturing sustainable solutions, through innovation, and phasing out unsustainable practices, through exnovation, to implement and maintain a sustainable circular society.

Links between the principles are articulated in the other principles. Thus, principles 1–4—reduced resource flows, decoupling of prosperity from material use and consumption through sufficiency and efficiency approaches, circular design (outline above), and circular business models for social, environmental, and economic value and impact set the scene for a modified economic model. Meanwhile principles 5–9 address more radical socio-political changes and mechanisms associated with circular society—consumption transformation, citizen participation, etc. There is an allusion to sustainability transition in principle 6, albeit with multiple possible outcomes, as indicated by principle 8. Changes must be enabled by participatory design and a return to strong sustainability as the foundation of politico-economic change. These radical proposals for designing more preferred socio-economic

situations require multi-stakeholder, multi-level processes of engagement and outcome. Principle 10 advocates for system analysis and 'redesign' in support of continuous learning and evaluation of transformation pathways. Achieving these aims will require a coordinated multi-level and multi-stakeholder engagement, including key political, economic and socio-cultural changes towards a new circular socio-technical regime, as proposed in sustainability transitions theory (Geels 2011).

Table 1 lists the principles (altered in some cases), provide a concise outline, and then identify core concepts and approaches which are alluded to in these. In some cases, the concepts alluded to derive from the original paper, while for others, relevant concepts and approaches were added. For the latter, illustrative references are provided and add a column with links to existing design strategies and approaches. The lists and examples are not intended to be exhaustive, there is significant overlap between principles and concepts, hence design strategies could be placed in more than one category and the table is intended to prompt the reader to consider the scope of the new landscapes of design (Sanders and Stappers 2008).

Principle	Short definition	Existing related concepts	Design roles
Nature positive economy	Material extraction rates and energy generation for production and consumption balanced by return to environment, within the planet's carrying capacity	Nature-based solutions (Seddon et al. 2021). Ecosystem stewardship (Chapin et al. 2010). Bioeconomy (D'Amato et al. 2017)	Nature positive design (Birkeland 2022)
Reduce and decouple resource use	Progress is decoupled from unsustainable material use through a focus on efficiency, sufficiency, and dematerialisation	Material circularity (Wiedmann et al. 2015), consumption-based circular assessment (Brown et al. 2018). Sufficiency-driven business models (Bocken and Short 2020)	Eco-efficient design (Ljungberg 2007). Cradle-to-Cradle Design (McDonough and Braungart 2010)

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Principle	Short definition	Existing related concepts	Design roles
Design for circularity	Transform industrial systems, supply chains, materials, and products, using "R-ladders" and whole-system assessments of solutions (P10)	Industrial symbiosis (Lifset and Graedel 2015). Industrial ecology. Waste hierarchy. Circular supply chains (Bressanelli et al. 2019). Life cycle assessment (Unep 2003). Complex value assessment (Iacovidou et al. 2017). Exnovation (Fossati et al. 2022). Sustainable Supply Chains (Smith 2008)	Circular product design (Sumter et al. 2018). Life cycle oriented design (Aurich et al. 2006). Sustainable Circular Design (Moreno et al. 2016)
Sustainable circular business models	Governance enables business models to internalise social and environmental costs of materials and products into their prices	Sustainable circular business models (Antikainen and Valkokari 2016; Bocken et al. 2020)	Design sustainable circular business models (Lewandowski 2016). Designing social business models (Burkett 2013)
Transform consumption practices	Systems of provision enable sufficiency-oriented, demand-driven resource use and more sharing, service, and experience-based consumption	Performance-based economy (Stahel 2010). Post-capitalism consumption (Hobson and Lynch 2016). Sufficiency (Lamberton 2005). Systems of provision	Social enterprise (co)design (Selloni and Corubolo 2017), experience-based design, sustainable product service design (Vezzoli et al. 2017)
Multi-stakeholder social business and innovation	Participatory social innovations bring people, business and policy makers together across system levels	Commons collective action (Ostrom 1990). Social enterprise (Teasdale 2012). Social innovation (Mulgan 2010)	Design for social innovation (Manzini 2015), Co-design for social innovation (Britton 2017)

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Principle	Short definition	Existing related concepts	Design roles
Coordinated multi-level policy and practice	Coordinated implementation of circular economy strategies and actions with societal actors across scales at key intervention points	Sustainability intermediaries (Kivimaa et al. 2019). Circular Governance (Ddiba et al. 2020). Multi-level Sustainability Transitions (Loorbach et al. 2017). Circular Policy (McDowall et al. 2017). PESTLE analysis (Mishra et al. 2019), Participatory Situational Analysis (Koutra 2010)	Future scenario design (Kishita et al. 2016), low-carbon scenario co-design (Shaw et al. 2009), Context analysis
Promote diversity and flexible solution implementation	A plurality of perspectives and local solutions for circular economy and a culture of knowledge exchange and learning across society for resilient circular economy processes	Resilience thinking and practice (Biggs et al. 2012). Scenario planning and design (Kahane 2012). Community participation (Sanoff 2005). Participation process management	Participatory social design (Ralph Boch et al. 2020). Participatory action research
Political economy for prosperity and well-being	Move from short-term GDP focus to long-term prosperity, well-being and environmental quality as goals	Well-being and prosperity focus (Jackson 2009). Doughnut Economics (Raworth 2017). Strong sustainability (Schröder et al. 2019). Multi-dimensional prosperity (Sands 2015). Multi-dimensional value	Policy co-design (McGann et al. 2018)
System design and assessment	Systems thinking approaches to the design and evaluation of circular proposals and transition processes	Planetary boundaries (Rockström and Steffen 2009), Systems thinking (Meadows 2008). Precautionary principle; Resilience thinking (Folke et al. 2010) Complex value assessment	Systems thinking in design (Mononen 2017). Complex value assessment

Table 1 expanded sustainable circular design R-strategies

R0 refuse	Sufficiency-based demand for products and exnovation of unsustainable products. The design and marketing of products and services will be refused where they have unsustainable outcomes of material choices and energy, and do not match the other R-strategy criteria, within the boundaries of a just society
R1 rethink	Rethink the economy, business and industry, and the role of public goods and markets. This entails new business and service models, social innovation, and consistency with a well-being focus. Rethinking enables the other r-strategies and is a result of the participatory processes listed above. Overall rethinking how demand for resource use is met in an economy, i.e. how products and services reach consumers. There is an element of rethinking what are needs and what are actually wants, which may also fit into reduce
R2 reduce	Eco-efficiency in all its facets as well as energy reduction applied throughout the system. This strategy is an outcome for materials, energy use and emissions of applying the other r-strategies. It can extend from products through to buildings and other systems. Industrial symbiosis and other practices, e.g. cradle-to-cradle design also enable this outcome. Reduce is really about sufficiency and seems a difficult concept to grasp because it is about reducing the overall pile of resources used in an economy (and not just about stemming the inflow of new materials by recycling more for example)
R3 reuse	New business models and services promote affordable sharing of products and are a result of the refusal of the status quo, a rethink of how we consume and produce a reduction in material and energy use. Not only are products per se re-used by second markets but they are designed for this prolonged value (e.g. Sivaloganathan and Shahin 1999). Here we can also think about new roles of consumers, who play an active role in enabling reuse
R4 repair	Products designed for easy repairability by consumers or services, entailing of course not only a rethink of design, refusal of non-repairable products and a reduction in materials and energy, but also enabling the reuse of products. Design for repairability (Rosner and Ames 2014), modularity, repair cafes and business and employment based on this promoted. Includes right to repair and transparency about designs to enable repair. Disassembly as well as modularity and repairability
R5 refurbish	A used product has those elements replaced that enable it to continue in its original or upgraded function. Similar to R4 and R3 this entails a rethink of business models and design for refurbishment. This principle builds on existing examples and can be extended to include building refurbishment or retrofit
R6 remanufacture	Remanufacturing is a process in which components and products are sorted, selected, disassembled, cleaned, inspected and repaired or replaced before being reassembled and tested to function as good as new or better [217,218]. Arguably, remanufacturing has to follow a standardised industrial process that is "fully documented" and "capable of fulfilling the requirements established by the remanufacturer" (internationally agreed remanufacturing (Velenturf 2021). Design for remanufacture (e.g. Hatcher et al. 2011) is included here. This entails modularity regarding simplification in the diversity of product components for multi-purpose reassignment

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Table 1 (continued)

R7 repurpose	Products designed to enable their elements or totality can be used again in products with another function (e.g. Eike et al. 2020). Repurposing is part of a rethink of consumption and the economy and avoids recycling processes. It can be enabled by so-called digital marketplaces but also can entail the re-purposing of product elements, such as motors, into new applications
R8 recycle	Products are so designed with materials that they are fully recyclable into new products and markets. This entails that other r-strategies have been first deployed before the product or item passes to recycling. Note that the presence of recycling infrastructure and flows is not a guarantee that recycling is contributing to reduced emissions or consumption
R9 recover	Bioeconomy allows for products to re-enter the biosphere and incineration for energy recovery is avoided. Also, biogeochemical processes, which is about safely entrusting materials back to natural biogeochemical processes. An example could be a landfill where we're mining valuable materials and eventually only leaving materials that can safely return to become part of natural capital over longer periods of time

In sum, design in its expert and diffuse modes can contribute to promoting all aspects of the sustainable circular economy principles. For designers, this will entail multi-disciplinary collaborations and greater knowledge and experience of the social, environmental and economic theories and concepts listed above. While there will still be a place for traditional expert industrial design concerns, including eco-efficiency practice, material choices and life cycle thinking, new areas for design will include sufficiency thinking, business model design, systems thinking and participation in multi-stakeholder social innovation and policy. This will entail rethinking design education and the spaces of practice to include such complex environments. Such an approach will also entail inviting those outside of expert design to experience the value of participatory scenario-making for circular policy and futures and prototyping these social innovations. In this respect, circular design is consistent with existing proposals for a systems-oriented transition to a new economy, driven by new product service systems (EEA 2019).

Although only explicitly mentioned under principle 3, R-ladders are a set of ten principles that are traditionally defined in relation to product design. Within a circular society, they have a much broader application to all the principles. These R-strategies support each other and apply more broadly to all the spaces of the economy, environment and society listed above. As a result, R-strategies can be used as another way of describing principles that are consistent with sustainable circular economy (SCE) principles. Thus, circular design based on SCE principles leads to a new application of the R-ladder consistent with all the principles above.

While there are examples of circular design initiatives scattered in the literature and in training materials (Schmidt et al. 2020), they remain few and of limited scope. Bringing visualisation, prototyping and other design thinking skills to these environments while simultaneously expanding the design education remit to include all facets of sustainability transition will help achieve not only Papanek's but also Herbert Simon's agenda for the re-design of society.

Recent work on systems assessment of circular economy proposals and challenges puts these principles in perspective by identifying how the private, public and civic sectors can intervene in the current system through specific R-strategies that such sectors can employ (Bassi et al. 2021). These proposals, however, take a traditional view of R-strategy definitions unlike those proposed above, since they presume the continuation of a mainstream economy rather than new sufficiency-based consumption, and allow for high rates of recycling and waste inputs as well as energy recovery. There is also limited or no place for laws and regulations or exnovation as part of a strong intervention in the economy.

5 Manifesto for the New Profession: Circular Design

Based on interviews with practicing designers, Sumter et al. (2020) suggest "design for a circular economy can be seen as an independent, upcoming field in the ever-evolving sustainability domain, and for which specific competencies, tools, and methods are needed" (Sumter et al. 2020, p. 1561), and they argue for further work on what this might imply for higher education. While agreeing with this and other formulations of circular design (e.g. McAloone and Pigosso 2018), arguably the scope of this new field is far broader. Circular design as alluded to in the ten SCE principles and r-ladder, but particularly in principle 3, is a manifesto for a new design approach. Although there is a general awareness of the need for a new design profile to match the circular society goal written into the sustainable circular design agenda (Moreno 2016; Earley 2017), the specification of this knowledge and change remains largely limited to either revitalising design for sustainability or rather holistic accounts of socio-economic transformation through design.

Sustainable circular design works with multiple stakeholders to re-design industrial systems, supply chains, materials and products based on implementing the full list of R-strategies. Circular designers are aware of the positive and negative system-wide impacts of their actions. In collaboration with the private and public sectors, as well as civil society, they contribute to the phasing out of unsustainable practices, which itself is a product of government and business interventions. One approach has been to specify the multi-level government, business and society interventions and policies required to make circular design possible, as in the action plan for Scotland (Whicher et al. 2018). Thus, as noted, the expanded sense of circular r-strategies and the roles for design based on the ten sustainable design principles offer a more specific framework for the circular design than hitherto—a new understanding of the 'designing out waste' mantra of mainstream CE.

6 Conclusion

The development and implementation of a broad expert and diffuse design approach to circular economy are hinted at albeit in a scattered fashion in the literature. In account of circular design, R-strategies typically are limited to the

material considerations of industrial and product design. The limited work on participatory and co-design approaches to policy and participation towards a circular society may acknowledge these professional industrial design concerns as a necessary but not sufficient approach to a sustainable circular economy. We suggest that recognising the broad remit of the practice of design, including some of its typical tools such as prototyping, visualisation and even business model design, may be a key way forward in redesigning the economy and society consistent with the aims of sustainable development. The r-strategies in this new approach constitute mindsets that can be brought to the task while the ten principles themselves articulate the system-wide changes in the economy, society and environment that need to be furthered. While various versions of new economic thinking, including the example of Doughnut Economics, post-Growth, and also Well-being economies and ideas, also propose disruptive and sometimes utopian visions of change, the approach we outline attempts to take a more pragmatic approach in acknowledging circularity as an important initiative but one which requires further work.

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