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8 Circular design in practice: eight levers for change

Abstract: Circular Design, as a practice and approach, has grown in popularity in the last decade, with academics and industry alike proposing many strategies and methods that facilitate this in products. Yet, very few day-to-day products are actually circular. Therefore, in this chapter, we sought to analyse and reflect upon what progress Circular Design has made within industry, uncovering the key barriers and opportunities for how it is implemented. Through interviews with industry experts applying Circular Design in practice, this chapter identified the 'classic drivers and barriers' influencing the sustainability of products but also identified several new insights or 'levers for change' that are impacting the advancement as well. It is proposed that if these levers are ignored, they could potentially continue to hinder advancement, but if addressed, could help to unlock activity within this area and help speed up the transition to a fully circular product system.

Keywords: Circular Design, implementation, products, industry perspectives

Introduction, review and approach

Evolution of circular design

Over the last 30 years, many design frameworks have been proposed to improve the environmental profile of a product (Sheldrick & Rahimifard, 2013). Generally referred to as Design for Environment approaches, they are concerned with implementing environmental considerations within the design process (Boks & Stevels, 2007). However, knowledge and understanding within this field have evolved over time, as has the terminology and classifications used. Below summarises some of the known approaches:

Green Design – focuses on a single issue or aspect of a design's ecological impact, such as the recyclability of the materials used

Eco Design – considers the whole life cycle of the product, aiming to anticipate and minimise environmental factors, from design to manufacturing and end-of-life (ISO/TR 14062:2002, 2002).

Sustainable Design – integrates the triple bottom-line perspective, aiming to synthesise ecological, economic and social considerations (Bhamra & Lofthouse, 2007)

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Within academic discussions, the nuances and varied benefits of these approaches are widely debated. Green design, at least within product discussions, tended to focus more on sustainable or green materials, and now is predominately associated with architecture and the built environment practices (Tseng et al., 2013).

Eco Design, on the other hand, primarily contributes to carrying out environmental assessments and strategic decision-making (Vallet et al., 2013), but can often be time-consuming and requires significant knowledge and expertise (Bhamra & Lofthouse, 2007; Sheldrick & Rahimifard, 2013). Lastly, Sustainable Design integrates the multi-stakeholder perspective, expanding our understanding of the implications of design, which challenges designers to embrace concepts of meaning and integrity of their products that goes beyond the obvious ecological benefits (Chapman & Gant, 2007).

However, considering the complexity of today's global product systems, traditional approaches that focus on optimisation, such as Green and Eco design are no longer fit for purpose and require a radical rethinking of product and system innovation to ensure that higher environmental gains can be made (Keskin et al., 2013).

Thus, while the Circular Economy concept has emerged as a promising framework for preserving and regenerating the environmental and economic value of resources within a system (Geissdoerfer et al., 2017), so too has Circular Design, as a method that can facilitate this transition by enabling materials, components and products to retain their value across multiple lifetimes (Den Hollander et al., 2017; Moreno et al., 2016).

Considered as part of taking a **Design for Sustainability** approach that aims to facilitate a systems shift through the radical redesign of products and services (Chick & Micklethwaite, 2011; Sumter et al., 2018), Circular Design requires designers and product developers to be systems-level thinkers (Moreno et al., 2016), able to actively integrate lifetime extension strategies while also being mindful of the implicit business model that surrounds the product (Bakker et al., 2014).

With the rise in popularity of Circular Design, researchers and practitioners from academia and industry alike sought to develop tools and strategies to facilitate circularity in products.

Examples from industry and third sector initiatives include: the "*Four Design Models" by* The Great Recovery Project (2013), "*Design on Demand"* by Forum for the Future (2016) and the "*Circular Design Guide"* developed in collaboration between IDEO and the Ellen MacArthur Foundation (2017).

Examples from academia include: "*Products that last"* by Bakker et al. (2014), "*Circular Design Framework*" by Moreno et al. (2016), "*Circular Design Tool"* by Moreno et al. (2017), "*Typology for Circular Product Design"* by Den Hollander et al. (2017), "Cards for Circularity" by Dokter et al. (2020) and "Circularity Deck" by Konietzko et al. (2020).

Though each suggests different procedures for enabling circular product systems, such as tools or frameworks, all offer insights regarding both design strategies and business model archetypes, the design strategies proposed, such as Design for Material Recovery or Design for Remanufacturing, address the more product-level factors, whereas the business model archetypes such as circular supplies or access-based models speak of how the function and value of the product is delivered and recaptured. This, perhaps, is what sets Circular Design apart from other Design for Environment approaches. Not only does it acknowledge and account for the entire product eco system through business model innovation, it integrates multi-lifetime thinking through product lifetime extension strategies, facilitating the maximising of the value of the products and materials from both an economic and environmental perspective.

Yet, it is important to note that while Circularity and Circular Design might offer some new insights, its philosophies and principles are built upon its predecessors. As these approaches evolved, regardless of the 'new' terms and practices that have been defined, the core ambition and driving principles of each, from eco design to circular design, remain the same: to reduce the environmental impact of products, through tactics such as reduce, reuse, repair and recycle.

Within each of these approaches, many *design for x strategies*, such as design for durability, reparability, serviceability, disassembly, upgradeability or emotional durability, have been framed and reframed over time by many authors and practitioners (Bakker et al., 2014; Haines-Gadd et al., 2018; Den Hollander et al., 2017; Ljungberg, 2007; Moreno et al., 2016; Mugge et al., 2005; The Great Recovery Project, 2013; Van Nes & Cramer, 2005). Nonetheless, to facilitate the environmental factors, the central values were carried forward with each iteration. Therefore, rather than defining and debating what design strategies might be classified as "eco," "sustainable" or "circular," it is perhaps enough to contemplate any and all tactics that fundamentally enable products to have extended use, reuse, be repaired, refurbished, remanufactured and recycled, as these ultimately are the key pathways that facilitate circularity and sustainability in products (Bocken et al., 2016; Nubholz, 2018).

Implementation of circular design in industry

In 2015, the European commission released a report, "*Closing the loop – An EU action plan for the Circular Economy,*" which outlined both legislative and non-legislative initiatives for accelerating the transition to a circular system. Due to the policies and regulations outlined, the initiative has not only helped to build new infrastructures and enabled a technology push for the region, but has also been a driving force for increasing momentum for research and the implementation of Circular practices across many industries (Mhatre et al., 2021).

Regarding Circular Design, evidence of how these practices have subsequently been implemented in industry is varied (Dokter et al., 2021). At a design level, several manufacturers have defined their own strategies and guidelines regarding circular product design (Dell, 2020; H&M, 2019; Inter IKEA Group, 2017). At a process level, some are exploring circular business models or services (Caterpillar, 2020; Signify, 2020), while at an organisational level, circularity targets are beginning to be integrated as part of their key performance indicators (KPIs) and commitments (BAM, 2021; Inter IKEA Group, 2019; Philips, 2020; Signify, 2020).

Though these examples indicate that we are moving in the right direction, most products on the market today still operate and cater to linear systems. Furthermore, considering that only 8.6% of the human-made world is classified as actually being circular (Circle Economy, 2020), the question is, what progress are we making towards a fully circular product system and what is hindering our advancement? Therefore, to address these questions, this chapter seeks to understand not only where industry is in its journey towards developing circular products and what headway is being made in circular design implementation, but also what is both positively and negatively impacting this progression.

Approach of the study

To address the key question of this chapter, knowledge and insights were collected from industry experts who are currently involved or were previously involved in the development of products, services and business models that utilise Circular Design principles and strategies.

This enabled the research to gather case study examples and evidence of how circular design is currently being put into practice. A qualitative approach was employed, as it allows for the gathering of rich, deep insights into the experience and context of participants and how this can influence practice and outcomes of a particular process (Ritchie & Ormston, 2013). This qualitative data was collected utilising semi-structured interviews conducted online using Zoom and Teams, over a two-month period. Each interview lasted 60–80 min and was recorded.

To gather a holistic perspective of Circular Design implementation, the key topics this inquiry sought to understand were related to: which Circular Design strategies are currently being considered, how and where these have materialised within the CE product initiatives, what are the challenges and success factors that lead to these being implemented and how Circular Design as a practice is being considered within the organisation. Table 8.1 shows what information was gathered from each participant as well as the list of questions that were asked.

Table 8.1: Questions asked in interviews.

Participant/company information	– Organisation – What the company produces – Their role within the company
General CE questions	– Can you describe how you work with the Circular Economy in your company? – What type of activities or projects do you undertake that are related to the CE
Circular strategy focused questions	– Can you describe a project that you consider has been successful in terms of implementing circularity at a product level? What key factors were important to its success? – What CE or circular design strategies did you consider? Why did you pick these over others? – What was your approach to developing the circular solution? Did you use any tools or methods? – When you considered adopting Circular design strategies, did you also contemplate the business model around the product as well? If so, in what way? – From your experience, which strategies are proving to be the most challenging to put into practice? And why? – Which strategies are proving to be the easiest to put into practice? And why? – Have you observed an improvement in the circularity or sustainability of your product as a result of adopting Circular design principles? If so, how have you measured that?
Diffusion of Circular Design questions	– When did you start using Circular Design in your products and what triggered this exploration? – Where do you think your organisation is on its journey into implementing Circular design? – In your opinion, has the way circular design been used and considered within the organisation changed over time? (i.e. Is this a niche concept or something that is becoming more mainstream?) – If more mainstream – what factors led to this occurring? – If still niche – what factors are preventing it from progressing?

Participant selection

It was decided that data would be gathered from organisations that have been exploring Circular Design within their products for over five years, as these participants would have more in-depth experience and knowledge to share. Within each organisation also, only industry experts who are directly involved in the Circular Design process were approached to ensure that they have the appropriate expertise.

Seven participants from six organisations were approached and interviewed. Their information has been anonymised, but following is a description of the organisations and what they produce.

List of organisations interviewed

- Organization A: A multinational home appliance manufacturer who sells products such as white goods, ovens and vacuums cleaners under several different brands
- Organization B: A multinational manufacturer of consumer electronics and healthcare products, such as large medical equipment
- Organization C: A multinational manufacturer of lighting products
- Organization D: A multinational manufacturer of optical and imaging products such as lenses, cameras, scanners and printers
- Organization E: A manufacturer of bamboo clothing
- Organization F: A manufacturer of parental products such as push chairs

Thematic analysis was employed, as, aside from being the most widely used method for analysing qualitative data, it is also the most useful for "capturing the complexities of meaning within textual data" (Guest et al., 2011, p. 11). The interview data was transcribed, collated and then analysed by all authors in order to identify the key implicit and explicit ideas or themes within the data. The results of this process are shown in the second section of this chapter.

Results

The progression of circular design

So, what progress have we made towards circular products and what is impacting the implementation of circular design within industrial contexts? All the organisations we spoke to are actively integrating circular design principles into their products and had at least one product or service offering that could be classified as contributing towards Circularity. Table 8.2 presents a summary of the main strategies they are considering:

Several of the organisations have been engaging in these circular activities longer than others, but it is also understood that lead times between sectors can differ, affecting the rate at which the outcomes of Circular Design can be realised. For example, within consumer electronics, it was suggested that *"We can design things now, but the evidence won't be seen in the marketplace for four-six years, in some cases: we are a slower industry"* (Organisation A). Regarding how they view themselves in their

Table 8.2: Summary of strategies and circular products on market.

	Strategies being considered	Circular offerings on the market
Organisation A	Refurbishment, Reuse, Repair, Design for Recycling, Recycled Content, Leasing	Subscription Robot vacuum in Stockholm (B2C)
Organisation B	Design for Serviceability, Repair, Refurbishment, Recycled Content, take-back, subscription models for consumer products, predictive maintenance	Refurbished MRI machines (B2B), Coffee machine 75% recycled plastic (B2C)
Organisation C	Serviceability, Longevity, Reuse, Upgradability, Refurbishment, Recycling, Take-back scheme Leasing	On-demand 3D printed lighting (B2C & B2B), Light as a service (B2B & B2G)
Organisation D	Durability and Longevity, Design for Assembly, Repair, Refurbishment, Adaptability and Upgradability	Refurbished high-value printers (B2B)
Organisation E	Material Health, Durability, Recyclability, Disassembly, Recycled Content, Emotional Durability, Take-back schemes	Sustainable denim, Circular Technical Jackets (B2C)
Organisation F	Durability, Longevity, Serviceability, Recycled Content, Leasing	Repairable and serviceable stroller, which is often resold on second-hand market; sells recalled or minor-defect strollers (B2C)

journey towards circularity, most organisations described themselves as either 'in the thick of it,' 'an intermediate phase,' or 'making progress', while Organisations C and E consider themselves to be ahead within their respective sectors.

However, regardless of the sector, there were some common challenges and successes observed within the interview data and two points became evident. Firstly, that many of the insights or factors identified could be categorised as 'classic drivers and barriers' within this context, and that they are still present and actively influencing the sustainability of products. Secondly, in addition to these typical factors, there are also several new insights or 'levers for change' that are affecting progress that, if ignored, could slow down progress; but if addressed, could help to unlock the activity within this space and speed up the transition. Therefore, these two points of reflection will make up the structure of this section and will be explored and discussed using examples from the interviews.

Classic drivers and barriers to change

The factors listed in this section were categorised as 'classic' due to the fact they have been either observed or explored as key barriers or drivers by previous studies and they cut across sectors.

Classic drivers

Legislation – Most organisations stated that the introduction of policy commitments and/or regulations actively influenced or triggered them to consider circularity and sustainability factors. *"Legislation is always an enabler; the momentum is really growing in society. But there is an urgency for action and the green deal is helping"* (Organisation C). Moreover, with new standards around 'Design for repair' being introduced, some organisations are not only wanting to be compliant, but excel and *"have a good score"* (Organisation B).

Customer demand – *"The Greta effect is real!"* (Organisation A). The growing societal awareness of environmental factors has not only impacted employee perceptions inside their companies, but has also resulted in increased pressure on organisations to engage with sustainable products. *"Overall, society is more sensitive to the topic, and we are seeing this with [our] people too"* (Organisation B).

For Organisation C, this is affecting demand and they are *"seeing a pull for circular products; our portfolio for professional luminous is growing for different purposes."* Ultimately, this trend of environmentalism is something that Organisation C is very much aware of and how it impacts the market; so believe *"if there is more pull, than it gets easier to implement."* However, while this is a positive step for circularity and sustainability, arguably though, the burden for change is still being placed on the consumer and not led by the organisation.

Investment in research partnership and exploring new resources – All organisations are currently, or have previously, engaged in research partnerships with academic institutions and/or other organisations to carry out research and development (R&D) towards circular offerings. Organisation E, in particular, identified a gap in technologies available for recycling textiles "*R&D is where the solutions are going to come from, and so we are very happy to get involved with this process ourselves."*

Sustainability Leadership – Organisations A, B, C and E attributed the successful implementation of circular design as a result of having leaders and managers who are actively driving this type of agenda. In particular, Organisation A remarked that *"Our CEO is a really strong Advocate [. . .] there's so much passion in the company."* Moreover with "*the trickle-down effect, pretty much everybody in the company has to have something about sustainability in their yearly review, which has never happened*

before. There are people who don't have it in their title, trying to show how they're contributing to sustainability."

This, in turn, is then impacting company perception, ultimately helping to attract talent to the organisation, as, *"for many employees, it is a strong reason why they joined the company."*

Classic barriers

Cost of circularity – Many previous studies have offered that often economic investment is needed to transition from linear to circular offerings (Ellen MacArthur Foundation, 2013; Ghisellini et al., 2016; Rizos et al., 2019). It is likely this will be required at a product level for activities such as R&D, and at a systems level for activities such as reverse logistics, for the recapture of value at end-of-life. While it is argued that circulating products will eventually result in a return on investment (Bocken et al., 2016), this still requires organisations to initially foot the bill. This was observed more significantly by Organisation F, stating that, within design, *"we can do whatever we like, assuming it doesn't cost too much,"* as ultimately, *"The bottom line is also always still a sticking point – how much will this cost, how much will it make us."* Though they attempted to implement recycled and circular materials into their products, they found that *"most of the more circular materials tended to be more expensive"* and this increase in cost was hard to justify to the organisation.

Mindset shift and proving the business case – Most organisations remarked that proving the value of the circular business models was a significant challenge, as not only are they *"still trying to determine where the real and best value is"* (*Organisation A)* within these systems, but the economic benefits of some activities are simpler to quantify; *"it's a lot easier to convince the business to use a recycled material in the product because this can be proved; the supply chain exists, it can be costed. To change the business model is much harder"* (Organisation A).

Investment will also be required to get these new business models implemented *as "[today's] products are made for one-time selling, so in order to redesign a new product and a new product ecosystem that is optimised and profitable for circularity, requires huge investment for such a service. This can be a big risk to take."* (Organisation F).

This ultimately requires organisations to consider new mindsets as well: *"it's relatively easy for design and engineering to propose how they would do something, quite difficult for the company, to have sufficient confidence to try a different way of working"* (Organisation B). Nevertheless, Organisation A is having some small successes in this area, having successfully launched a performance-based robot vacuum; citing a low barrier to entry cost as a main factor that drove uptake.

Issues of scale – All organisations reported the use of pilots or trials to explore circular products and services. However, Organisation A observed that scalability can

be an issue that hinders progress: *"In certain markets, certain offerings do well and others do not, therefore in terms of the scale of the business model, you can't just do it the same everywhere and think that it will work*."

Environmental trade-offs – Managing environmental trade-offs is a topic widely discussed in both design (Ma & Moultrie, 2017; Prendeville et al., 2014; Salari & Bhuiyan, 2018; Vanegas et al., 2018) and CE contexts (Bracquene et al., 2020; Glogic et al., 2021; Millward-Hopkins et al., 2018). Similarly, within industry, Organisation B remarked that *"if you've worked in sustainable design, you are always trying to understand these trade-offs [. . .] if circularity is the best option."* While Organisation E found balancing circular design strategies (such as emotional and physical durability, disassembly and recycling) a challenge from a technical design perspective, Organisation B found communication of these trade-offs to decision makers more crucial, stating that,

> The businesses are not used to this; usually, you need to be good at presenting these options to people[1] as well. It's hard for people to manage new thinking, then new terms and complex trade-offs. Sometimes they trust you; other times they are sceptical, and it's about making sure the trade-off is communicated properly to your stakeholders.

Organisation B is larger than Organisation E and involves many more stakeholders in decision-making processes, which is why this is probably more salient. Nevertheless, all organisations stated that Life Cycle Assessments (LCA) are central to how they make evaluations on which strategies to implement; however, Organisations B and D specifically stated that the business case or economic assessments 'really' influence what direction is to be considered.

Though positive that environmental assessments are considered as a best practice for product development, Organisations E and F both recognise their limitations when trying to implement new materials or product ecosystems, and are exploring new databases and data collection research to improve their accuracy.

In conclusion, though these points have been determined as 'known' or 'classic' factors within the field of circularity, it demonstrates that, intrinsically, some drivers are working and should continue to be pushed further, such as regulation and sustainability leadership, and that some barriers are yet to be resolved, and require more research and investment. However, it also shows that, although these companies are considered pioneers in Circular design, each organisation had only one or two products within their portfolios that could be considered as circular. Therefore, these typical drivers, while still relevant, are not enough, and there are

1 'People' within this context refers to key stakeholders of the product development process such as designers, product managers, engineers, business management etc.

other avenues or 'pressure points' that have been identified that require more attention, if we are to unlock the potential within this field.

Questions to contemplate further from this section

Does being circular really cost more than being linear?
How should we be picking which strategies to use over others?
What data do we need to prove the business case?

Levers for change

The factors identified within this section have been grouped together as they represent points that potentially, if overlooked, will continue to slow the progress of the circular products, but if addressed and developed, could act as linchpins for speeding up the transition.

1. Be a catalyst for change

From the data, it was observed that many of these organisations were acting as catalysts or facilitators for change, both up- and downstream within their supply chain. This involved activities such as educating their suppliers, facilitating new networks and engaging in thought leadership within their respective sectors to help integrate circularity into their products.

In particular, Organisation E wanted to ensure that at the design stage, their product could be fully recyclable at end-of-life. Traditionally, they relied on their upstream supplier to provide knowledge on recyclability of the materials in their product; however, they discovered these topics had not been considered. Therefore, they *"realised we needed to be facilitators of sorts"* and linked up a recycling processor with their supplier. Similarly, Organisation F wanted to use recycled content within their products but found this was not currently available, so are facilitating conversations with other materials suppliers to explore this possibility. Lastly, Organisation A are engaging in similar activities, however found that due to their brand pull in some markets, *"we have the scale for negotiation on some materials, components or processes, but we don't have for others."*

Moreover, beyond facilitation and driving new knowledge within manufacturing, Organisation E also feels that in the fashion and textiles sector, there is a significant gap "*between solutions and those that need solutions*" regarding circular or sustainable materials and appropriate end-of-life processing. They observed that some large brands do not want to invest in change, so they feel they should act on thought leadership on this topic: *"hopefully it will be smaller guys like us who will be able to push the bigger businesses in that direction."*

In conclusion, as more organisations engage in these discussions and attempt to drive change where they have influence (i.e. within their respective supply chains), the more these topics will diffuse into everyday practice. However, looking at the strategies these organisations are driving, they are primarily centred on materials and involve actors upstream more than downstream. So moving forward, while it is important these upstream discussions continue, it is vital that facilitation occurs downstream as well. This will not only assist in the establishment of the collaborative networks required to enable take-back schemes, re-use and the recapture of value, but will also help to demonstrate the business case for circular products.

2. Integrate downstream circularity

For some organisations, addressing upstream innovation (i.e. changing the design, replacing materials for more recyclable or recycled content) is proving to be easier than downstream innovation (i.e. setting up take-back schemes, subscription models etc.). All organisations we spoke to are considering and implementing recyclable and recycled content materials in their products; in particular, Organisations B, E and F have products in the market that are made predominantly out of recycled content. Organisation A remarks, *"Recycled materials have come a long way and there seems to be an increasingly healthy Marketplace. Companies are interested in this and I think the material suppliers realize that."*

However, downstream, ensuring these materials are recovered and recycled is proving to be a more challenging prospect:

> Hardest thing to do is end-of-life solutions [. . .], for fabric and textiles industry where there is no infrastructure for it; there aren't very many technologies that are scaled up and commercially available yet, and there is a massive disconnect between brands, their suppliers and recycling processors" (Organisation E).

Furthermore, Organisation B observed that recycling is not something that manufacturers like them have any direct control over; it is the Waste Electrical and Electronic Equipment (WEEE) system that manages this waste, not them.

While material innovation might be considered 'easier,' is it really the most pressing strategy to facilitate circularity in products? As Organisation E observed: *"to what extent is ensuring that there is recycled content a good idea, if it's not being recaptured?"* The upstream innovation guide developed by the Ellen MacArthur Foundation (2017) believes it helps to address the problem at the source by preventing waste being created in the first place, while most certainly true when considered for packaging. Is this the right strategy for more durable products with longer lifespans?

Extending the physical and emotional lifetime of a durable product at the use phase is the most important strategy for minimising its environmental burden (Bocken et al., 2016; Haines-Gadd et al., 2018) and should be considered first when designing for circular products (Den Hollandar et al., 2017). While only Organisation E stated

that they were actively considering the emotional durability, all organisations are considering physical durability factors. In particular, Organisations A, B, C, D and F found implementing strategies such as serviceability or repair at a design level to be relatively straightforward. However, initiating take-back schemes, leasing and the operations required for refurbishment, reuse or recycling are proving to be a much trickier proposition, especially for products in the B2C market, as Organisation C remarked: *"in the reverse logistics, there is still lots to be gained."* Despite the challenge, all the organisations are exploring the implementation of these initiatives, and Organisations B, C and D currently have these networks and operations established to recapture and refurbish high-value products, but only for the B2B market.

Moreover, Organisation C is taking things one step further and designing their products to be Circular-Economy ready.' They have recognised that while the downstream system is not ready to cycle these products just yet, when it catches up and the structures are put in place, their products will be ready, as the best current strategy for design to consider is to 'make the circularity of a product possible' and the rest will fall into place (Organisation F).

Lastly, Organisation E struggled with setting up reverse logistics, as the collaborator they partnered with could not handle the scale of returns and had to close the initiative down due to economic constraints. They felt they had 'done it the hard way' by trying to set up this initiative from scratch, but if were to do it again, they would partner with third-party suppliers to manage returns. This highlights another key concept of circularity – the importance of partnerships and collaboration – which will be explored further in this next point.

3. Be proficient in collaboration

For products to cycle in a functioning circular economy system, networks will need to be established to capture and cycle this value. This inevitably requires collaboration between system actors, and is cited as a key enabler for making circularity work (Organisation C). Yet, as several organisations highlighted, to create a *"working Circular ecosystem, this is the real challenge. This is where the real magic happens; in collaboration, not in the separate functions or disciplines; in collaboration, inside and outside your organisation" (*Organisation B).

To achieve this utopian vision of collaborative circularity, it is often proposed that partnerships need to be built on mutual benefits (Charnley et al., 2011); however, for Organisation A, this has been a point of friction: *"we can all see the benefits of collaboration, but when it comes to viable projects that the business will buy into, it's quite hard to find alignment because the interests are different."* While it could be argued that this is an indication of a mismatched partnership, Organisation B believes issues such as these arise due to economic constraints: *"it is the place we need to invest, we do not budget for collaboration; we reserve budget for product innovation, BM innovation, and not for collaboration."*

While increasing investment in collaboration could help to unlock some of these sticking points, this would also need to be examined in parallel with comprehension of circular economy concepts from a system-wide perspective. It was observed by Organisation C that:

> in the market, we do not have harmonised understanding of circularity; when I am at conferences, recycling companies only think about materials, other companies only think about spare parts harvesting etc. There is such a diffused way of thinking about circular. I think that is a big issue we have.

What was interesting about this point is that all organisations we spoke to are keen and willing to explore collaboration, but are finding the process time-consuming (Organisation F) and, on occasions, unsuccessful (Organisation A, E). Therefore, perhaps we need to be considering not only what methods or processes we need to facilitate for a better collaboration between system actors, but what expertise we might need to push this further. As Organisation B offers, collaboration *"should be looked at as a separate skill set, or competency area for any sustainability or CE professional."*

4. Have collective circular comprehension: pull in the same direction

> Even some people who are engaged in sustainability still don't really understand what Circular Economy or Circular Design really is (Organisation E)

In general, CE is still thought to be a 'niche' concept, both internally and externally. Subsequently, for some organisations, this has resulted in a varied understanding of what CE is and how this contributes to business functions. Organisation A considers CE to be a subset of sustainability, and even though considered to be holistically integrated across many different functions, they are sometimes faced with the question of *"do we want to just make our existing business more sustainable, or do we want it to be circular? In some cases, it's a bit of an either-or."* Moreover, some think circularity is just about recycling materials; for others, it is about business models.

Organisation D, on the other hand, is prioritising the development of a carbon-neutral product over a circular product, but is contemplating how circularity might contribute to this, which prompts the question, is there a tension between creating circular, sustainable and carbon-neutral products? Perhaps, though some believe it is just a matter of better aligning net-zero goals with circularity principles (MI-ROG, 2020). Regardless, what this could indicate is that we need to ensure that not only is everyone on the same page, but are also reading from the same playbook. As Organisation E observed how getting different teams such as both product and marketing 'buy into' the concept, and understand 'how this impacts their job,' really helped in the successful implementation of their circular products.

For a few organisations, if circularity and circular design is also considered as a long-term strategy for the organisation, this will both help to align internal activities and result in a competitive advantage in the future. This final factor was observed most significantly with Organisations B and C and is viewed as making the most headway in this regard in two ways.

Firstly, both organisations integrated 'circular product revenue targets' as part of their KPIs, which has significantly helped to drive change. While Organisation B is creating strategic product roadmaps for how to reach these targets, Organisation C compared CD principles with their existing KPIs to ensure these translate into circular products. And while CE or sustainability was previously seen as part of compliance, it is now viewed as 'becoming core to the business, and employees are considering integrating these ideas into their existing ways of working.

Secondly, both attribute business structures as an enabler for the development and delivery of circularity. Organisation B has a horizontal unit that advises and guides many different departments and teams (from product to R&D to operations) on the best strategies for circularity, from both technical and business-model perspective. By not being tied to a particular department or a product line, this enables them to have a more holistic, systems view of driving the circular product development process.

Organisation C, due to the nature of their focus on offering service-based circular offerings, has created a dedicated "*sales force that understands the proposition, can sell it, and is comfortable enough to explain the benefits to the customer.*" And by having a "*good service team,*" this can really help to manage the relationship and provide service through the contract. They highlighted that the ability of the sales force to successfully communicate the benefits of switching from linear to service-based model was crucial for adoption, and so is something that must be implemented.

5. Build up circular capabilities: knowledge, tools and metrics

Most organisations indicated that they are constantly developing their knowledge and capabilities around circular design and circularity principles, which was being facilitated through various activities. Firstly, through continuous learning practices, such as training programmes or looking to external resources and guides: Organisation E had employees attend an academic training programme on the circular economy, while Organisation C runs its own training internally on Circular Design and circularity. Most organisations stated they took inspiration or influence from external guides and tools developed by academia and sustainability consultancies; in particular, Organisation E found the Ellen MacArthur Foundations principles of sustainable denim to be a helpful starting point for their exploration, as *"this gave us something to aim for – a really clear set of guidelines."*

Secondly, through the internal development of tools and methods for both facilitating circular design and measuring circularity: Though Organisations B, C and D have developed their own internal design guidelines for enabling circular

products, all the organisations are actively using circular design strategies and frameworks in one capacity or another. Regarding measuring the environmental performance, most tend to use LCAs as the primary methods of assessment. Yet, when considering circularity specifically, some are exploring this in more detail than others. Organisations B and C have defined specific metrics for measuring the circularity of their products, Organisation E has some indication but does not measure these formally, while Organisation F, on occasions, monitor the resale value of its products, which it considers as more of a 'quality indicator' than a circular indicator.

Measuring product circularity – not only its carbon footprint, but also its ability to be circular – is an interesting challenge, one that many in academia are trying to solve (Boyer et al., 2021; Bracquene et al., 2020; Linder et al., 2017; Mesa et al., 2018; Shevchenko & Kronenberg, 2020). However, it is promising that the industry is also developing knowledge in this area as well, which, hopefully, will help speed up the transition in this space, as Lord Kelvin famously offers, *"if you cannot measure it, you cannot not improve it"* and this is certainly something that needs improving.

Lastly, Organisations B and C formalised some of these activities through the development of *'Centres of Excellence'* that have enabled the company to not only to build but also consolidate their knowledge and capabilities in sustainability and circularity, internally. However, it was also reflected that to truly help implement circular design into products, we need to go beyond developing expertise for a select few, and integrate it more widely within the organisation, and that *"Real change happens within the existing functions of an organisation when people become aware, activated, engaged. To execute these new values of CE is the real journey; basically, to make yourself obsolete; to make CE thinking, the norm"* (Organisation B).

6. Tweak and totally transform: Where to start

For most organisations, there was a tendency to servitise existing products and tweak the design over time to improve circularity, rather than start from scratch to create entirely new circular product and service offerings. One reason stated for why this was the case is that *"you have to start somewhere"* (Organisation B), but it is assumed that considering the time it takes to launch a product, servitising existing units requires fewer up-front costs and provides the opportunity to explore the business case. Most improvements being implemented were about increasing serviceability, ease of refurbishment, disassembly and repair; all factors that are necessary if products are to be maintained, recaptured and redeployed for future users or use cycles.

However, this prompts the question, to what extent can Circular Design be retrofitted? As Organisation F argued, most products and product ecosystems are designed for one-time selling and would need to be completely redesigned if they are

to be optimised for profitability. So, would there come a point where you might need to start from scratch anyway?

Not necessarily. It was observed that this could be dependent on whether you are discussing a high-value product or a low-value product. Organisation B offers:

> large equipment has inherent value, typically high enough for a business model or service model to be good enough, without the need to contemplate Circular Design strategies as much; these systems have been optimised to work efficiently across a longer period of time, due to the investment needed for manufacture. [. . .]. For smaller equipment, the business model cannot be made unless you design for circularity, from the start. Only when you start integrating Circular Design, can you begin to repurpose, in a profitable way, products into the market.

With this in mind, right now, is circularity only being implemented for high-value products? One limitation of our data set is that we were only able to speak to manufacturers of, arguably, high-value products (mostly electronics, etc.). Although Organisation E produces lower-value items (socks and underwear), their current circular offerings on the market have a higher price point, which they believe contributes to the likelihood that it will fulfil its circular potential and not be discarded at end-of-life: *"For higher-value products, consumers are more likely to research it, donate it, reuse it, and maintain a longer relationship with it; so more likely to care where it will end up."*

At least for high-value equipment and products, it is thought that *"the business model is leading"* (Organisation B) and these types of products are, in general, considered to be "*assets in the field"* (Organisation D) that can be a source of revenue for many years, if they are designed to last. However, arguably, the business model is also leading for low-value items as well, as ultimately this influences how it is designed. Nevertheless, it is also thought that perhaps as servitisation of products becomes more commonplace to consumers, the redesign of products can properly begin to suit circular business models (Organisation, F).

Moreover, Organisation A reflected that in most cases, *"the hardware takes a lot longer to develop than the software,"* so digital products that help enable the servitisation of existing products is faster to roll out, and will demonstrate the value much quicker than physical changes. So perhaps then, it could just be a case of adopting different approaches for different types of products.

At least for Organisations C and E, they decided to go back to the drawing board and develop their product offerings with a circularity intent. For Organisation C, in particular, not only does circular design increase the ease with which the products can be maintained and servitised, it also enables *"an extension of functionality"* over time, such as the inclusion of new features, as, *"there is a lot of freedom for functionality when you do the right design."* So, one could even argue, beyond improving the sustainability that, perhaps, circular design is inherently just good design.

7. Consider the circular consumer

Thus far, research on the circular economy and circular design has tended to focus more on technical challenges of implementation (Lofthouse & Prendeville, 2017) and less on the role and experience of the consumer in this new type of system. A few studies have tried to address this perspective. For B2C products, one study created a tool for new product developers to design opportunities for emotional connection so that consumers want to keep and maintain their products far longer (Haines-Gadd et al., 2018). Others examined the attitudes of consumers towards second-hand or refurbished products (Baxter et al., 2017; Mugge et al., 2017) and the role of the consumer in the circular economy (Camacho-Otero et al., 2020; Chamberlin, 2021).

For the B2B market, these emotional and behavioural issues were observed to be less of an issue (Organisation D), but for the B2C market, understanding how consumers feel and engage with circular products is an important step that must be considered to accelerate the transition as *"we learn so much more by having more people buy into it and really what we're trying to do is learn and figure out how viable a business model is"* (Organisation A).

Within the industry, this is starting to be more comprehensively examined as well, and most organisations indicated they were investigating the consumer experience dimension of circular design as *"it is a bit futile to design entirely circular product that then no-one wants to buy or wear; so placing the needs of the consumer needs at the core is key"* (Organisation E). Moreover, by adopting the principle, *"By thinking with the customer, you can help to further improve the performance"*, it helps to build a product (Organisation C) where users develop more meaningful relationships with it and this approach could contribute towards your organisation being considered a preferred supplier.

But it was also remarked that, especially for circular consumer products, this may require participation from the user to help make this happen. For example, Organisation E is exploring one such possibility and found that:

> in order to make the jacket truly circular, the waterproof level of the jacket is not as high as we'd like, and needs to be refreshed once a year; so once you buy the jacket, you also receive a lifetime subscription service and receive a liquid wash that goes in the washing machine.

Also, if a product needs to be repaired, Organisation A wants to understand consumer attitudes and willingness to engage in this process and distinguish *"how to make that easy and desirable."* Furthermore, to enable repair or returns at end-of-life, continued consumer engagement will likely be required to maintain some visibility on the products, as *"we've done all the work to make sure it can be recycled; why wouldn't we make sure it does get recycled?"*

Lastly, for some organisations, lack of information or data on existing or future consumers is slowing down the progress: *"The biggest challenge was finding a customer for used products"* (Organisation D); they had predicted that these were most likely in developing markets, but found it difficult to propose a solid business case

and products to investigate this further. While for Organisation A, due to legislation being different between regions, there is a varying willingness from consumers to share data on product use to help inform circular design improvements: *"Circularity only lives with the flow of data . . . data is the oil, if you can't understand the flow of things, then you can't create a circular economy."*

In summary, it is a positive step that organisations are considering the consumer side of the circular products, but this is still an undeveloped area for circular design in general, and we need that consumer pull and acceptance if these types of products are to be more widely adopted and integrated.

8. Integrate feedback loops to improve circularity

Information feedback loops are important for enabling closed-loop supply chains as they facilitate the gathering and sharing of data that can help improve product design and optimisation of the value within the supply chain (Koppius et al., 2011). If this is missing within companies or systems, this can result in lack of awareness of how upstream changes impact downstream processes. Therefore, in most cases, this means there is no incentive for businesses to consider how circular design strategies might improve the environmental or economic profile of their products or systems. As Organisation F remarked, currently within their organisation, there is *"no business driver or case for making improvements*." That, *"if [they] were to enhance the serviceability of the product,"* they would not be able to measure or offer evidence that *"it would save [them] so and so money"* or not. They argued that this *"feedback loop is missing"* and that *"it could be better, more visible*."

In addition to internal feedback loops, external feedback loops can be useful for improving the circular design of the product as well. As shown with Organisation E, they gather feedback from their consumers regarding any issues that arise as result of circular design changes made to the product. This not only allows them to continue to adapt and improve circularity without affecting satisfaction, but also offers the company the opportunity to provide a rationale behind their design decisions to the consumer. Similarly, Organisations B and D gather feedback information from service engineers to design to improve the ease of repair and refurbishment of their products as well. Therefore, organisations implementing circular design should consider implementing initiatives that allow them to gather, measure and input data upstream, as ultimately this could help companies to make more informed, intelligent decisions regarding the sustainability and circularity of their products.

Questions to contemplate further from this section

How do we encourage consumers to share data to make products more circular?
How can we capture data on our products to improve decision making?
What skills should we learn to improve collaboration?
What does making products 'circular economy ready' entail?

Discussion and conclusion

Pace of change: are we accelerating the right parts of the system?

Climate research is urgently calling for a radical redesign of how we deliver value through products and services, if we are to slow the impact of climate change (IPCC, 2018). Therefore, we must be mindful of which parts of the system we are addressing and to what degree these will impact the pace of change for this transition. It could be argued thus far that most of the circular thinking has been applied to the 'low-hanging fruit' opportunities (i.e. material innovation for recycled, renewable and recyclable content and the servitisation of high value products). While these are important activities towards making the transition, they are arguably incremental steps of innovation and we are still predominantly operating in the business-as-usual mindset, selling one-time products to consumers and relying on downstream actors to manage the problem. These pioneering organisations are taking steps towards mitigating these issues, yet there are few circular products available on the market; many barriers and challenges still to overcome and there are many more stakeholders within the system who are yet to begin their journey. It is important to note, however, that most organisations we spoke to are large multinational organisations and are undergoing a transition from linear to circular offerings, rather than building in this approach from the start, which inevitably will take longer.

Therefore, reflecting on the 'eight levers for change' identified:

1. Be a catalyst for change
2. Integrate downstream circularity
3. Be proficient in collaboration
4. Have collective circular comprehension – pull in the same direction
5. Build up circular capabilities – knowledge, tools and metrics
6. Tweak and totally transform – where to start
7. Consider the circular consumer
8. Integrate feedback loops to improve circularity

It is proposed that if these were to be addressed more significantly, they might help to unlock some of the sticking points that organisations are experiencing, which could not only mitigate the classic barriers such as proving the business and scalability, but also potentially speed up the transition to more circular products. However, it is also recognised that this is not an exhaustive list of suggestions and recommendations for how to enable circular products. The focus of this study was on the implementation and advancement of circular products, from a design and organisational perspective. There are wider system enablers such as tax breaks and

financial incentives that also could speed up the pace change within this area, such as those adopted in Sweden (Starritt, 2016).

Internal organisational challenges

As mentioned in the literature review, circular design principles are an evolution from previous environmental strategies and research. As such, this can diffuse understanding and perspectives on what being 'circular' or 'sustainable' might entail. While, to some, this might be seen as a matter of semantics – to create functional, cohesive circular product ecosystems – there needs to be a shared understanding about what all of us are trying to achieve. Though all the participants we spoke to are acting as CE champions inside their respective companies, most stated that circular thinking is still considered to be a niche concept; therefore, getting company-wide buy-in and comprehension is a huge challenge. To address this challenge, organisations need to firstly continue to build capabilities and knowledge around circular economy topics so that each stakeholder understands how their function contributes towards building circular products systems. And secondly, encourage organisational leadership figures to galvanise their organisation towards this direction through measurable targets and internal incentives, which would not only help to inform priorities, but also keep everyone motivated and focused on the north star of what we are aiming for.

Externally managing circular product ecosystems

Value in a circular economy does not flow in one direction; it is something that is exchanged by system partners (Lancelott & Haines-Gadd, 2020). Managing the flow of value between stakeholders is a huge challenge, especially if there is lack of knowledge of sustainability topics amongst suppliers and customers. While some organisations are acting as catalysts for change, this is often only within their respective supply chains; but hopefully over time, as this thinking spreads, these practices will become more commonplace. Furthermore, although upstream innovation amongst some of these organisations is seemingly 'easier' to implement than the downstream processes, as we move more towards the concept of value constellations rather than value chains, perhaps this will become less of an issue.

The evolving role of the circular designer

The implementation of circular design was observed as an activity that goes beyond the designer and is a process that involves many more actors within the organisation.

While the design stage is still an important part of integrating circular principles, to make products truly circular, partnerships, networks, logistics and infrastructures need to be established to support the circular product eco-system. Although the role of the designer has evolved significantly over the last 30 years, as part of implementing circular thinking, it may need to continue to develop even further.

Beyond managing the environmental trade-offs between different strategies, implementing circular design strategies from a technical products design perspective was shown to be a relatively straightforward activity. It was the more system-level challenges such as collaboration between stakeholders or initiating reverse logistics that are causing more friction. As Organisation B observed, collaboration is hard and is a separate skill set that is needed from those implementing circularity. Therefore, perhaps designers and design thinkers, who are often considered to be facilitators, translators, communicators and systems thinkers, could be the actors needed to make this circular transition occur more smoothly, ultimately expanding the role of the designer over time, requiring them to become, in a sense, 'circular design thinkers'.

Limitations

This study was only conducted with six companies, most of which are large-scale organisations. To advance this perspective of circular design within the industry, further interviews with smaller organisations should be conducted.

Conclusion

In conclusion, within this chapter, we sought to understand what progress has circular design made within the industry. Through interviews with circular design practitioners who are implementing these into products, it was observed that there are many 'classic drivers and barriers' that are still present, both enabling and hindering the adoption of circular thinking, such as legislation or sustainability leadership and proving the business case. However, there were also new insights that have not been discussed within the literature and have been proposed as the 'eight levers for change' that, if addressed more significantly, could help accelerate the transition to more circular product ecosystems. We need organisations to be catalysts for change within supply chains and consider how to integrate downstream circularity as well as upstream circularity. They should increase their proficiency in collaboration, ensure there is a collective understanding of what circular means and to continue to develop their capabilities in circular practices. Organisations should both tweak and totally transform their products, depending on what it is, consider the circular consumer experience and, lastly, ensure that feedback loops

are integrated to help drive improvements. It is through these actions that we might finally get to a space where being circular is not niche, but the new business-as-usual approach.

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