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Circular Economy: Is it enough?

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Contents

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1. Introduction

Recently, the concept of the circular economy has gained traction in industry and policy as a pathway to deliver resource efficiency. Its growing popularity is reflected in industrial campaigns and a flurry of grey research literature.

While not a new concept clearly its widespread appeal has never been greater. This is because industry at large recognises the need to transition from a linear take-make-dispose model of production and consumption. A key driver for this is increasing awareness of resource scarcity, risks to business competitiveness and the potential impact this may have in the long-term. In a recent UK based survey of 435 companies in total 72% indicated that they are looking to engage with waste management providers to collaborate and implement closed loop systems (Edie, 2013).

Purported incentives and cost reductions seen through circular economics are compelling, with vast resource efficiency gains claimed through implementation of closed loop manufacturing systems. One report commissioned by the Ellen McArthur Foundation (2013) found that adopting a circular economy approach could save European manufacturers $630bn a year by 2025. As global demand for sustainable solutions reaches criticality, circular economics offers unparalleled prospects for industry.

This brief position paper discusses the importance of an ecodesign perspective within a circular economy. Firstly, we set out the main similarities and differences between ecodesign and circular economics. Following this we discuss key challenges in implementing circular economy principles within industry. Finally, we reflect on possible alternatives to the circular economy and the significance of these models for long-term environmental protection and social wellbeing.

2. Circular Economy or Closing the Loop?

This section explains the difference between the concepts of circular economy and closed loop manufacturing by presenting definitions from the academic and grey literature.

The definitions presented in Table 1 show how both concepts involve the reverse flow of materials through return systems, remanufacturing, repair, recovery, recycling and reuse. And this is widely accepted.

Circular economy definitions consider economic growth, promote renewable energy, the notion of ‘restoration’ and the ‘replenishing’ of resources. Importantly, the concept of closed loop can also be identified within circular economy definitions. This aligns with the Ecodesign Centre’s view of the circular economy as a broader agenda than that of closing the loop.

However, though broader, it is not entirely clear how a circular economy approach could restore or replenish natural resources. It is true that circularity can reduce the need for raw

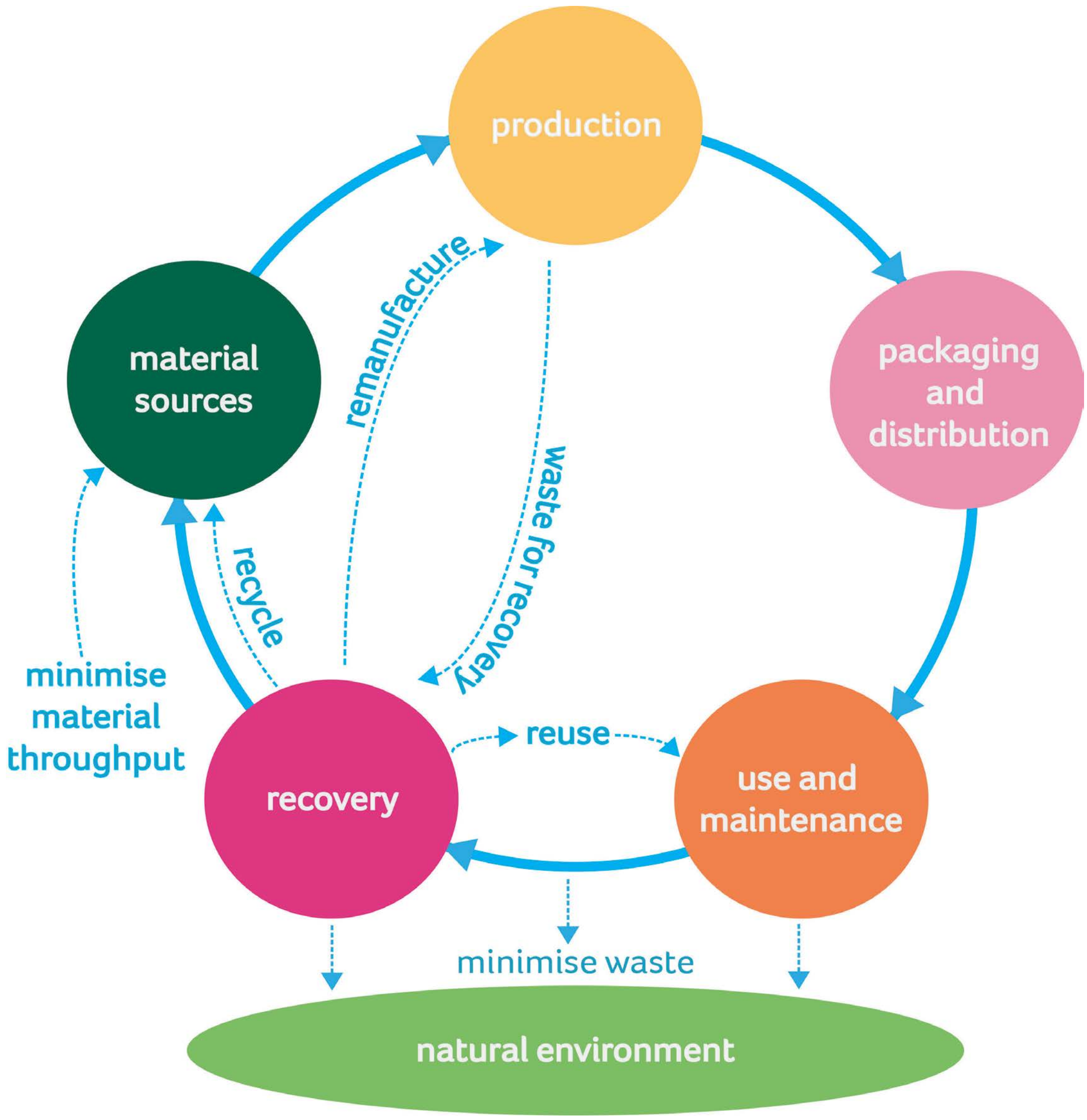

Figure 1. Closed Loop Production System (adapted from the OECD, 2009)

material extraction thus alleviating stress on the natural environment. But this differs from 'restoration'.

Finally, it is essential to recognise that circular economics and closed loop approaches advocate for material and resource efficiency over and above environmental impact reduction. It is also essential to recognise that there are environmental impacts resulting from product life cycle stages other than raw material extraction (this includes environmental impacts of recycling processes). In Section 2 we discuss the role of ecodesign in bridging this gap.

Table 1. Definitions of the Circular Economy

Source	Year	Definition
Ellen MacArthur Foundation	2013	"Though still a theoretical construct, the term 'circular economy' denotes an industrial economy that is restorative by intention and design...products are designed for ease of reuse, disassembly and refurbishment, or recycling, with the understanding that it is the reuse of vast amounts of material reclaimed from end-of-life products, rather than the extraction of resources, that is the foundation of economic growth."
Ellen MacArthur Foundation	2013	"It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems and within this, business models."
McKinsey Global Institute	2011	"In addition to meeting current demand/consumption needs, a circular economy also actively invests in improving resource systems and increasing their resilience to ensure their continuing availability in the future. In short, it replaces a through-put-and efficiency-driven view that ultimately degrades capital with one where capital rebuilding and maintenance offers an upward spiral or virtuous cycle, and a continuous flow of materials and products."
Green Alliance	2011	"The circular economy requires careful management of material flows, which are of two types. These are characterised by McDonough and Braungart in Cradle to Cradle: Remaking the Way We Make Things as biological nutrients—materials designed to re-enter the biosphere safely and rebuild natural capital, and technical nutrients, designed to circulate at high quality without entering the biosphere."
Edie	2013	"A circular economy is one in which resources are kept in use for as long as possible, by extracting the maximum value from them while in use, then recovering and regenerating products and materials at the end of each service of life."

3. Comparing Ecodesign and the Circular Economy

This section introduces ecodesign and the strategic and operational alliances between ecodesign and the circular economy. It also briefly discusses where these concepts begin to diverge.

Ecodesign is a strategic design management approach to reducing environmental impacts across the whole product life cycle. The European Commission defines ecodesign as "taking into account all of the environmental impacts of a product right from the earliest stage of design. In particular, this avoids uncoordinated product planning (for example, eliminating a toxic substance should not lead to higher energy consumption, which on balance could have a negative impact on the environment." Traditionally, ecodesign definitions focus on products but have evolved to include services and systems (see Sherwin and Evans, 2000).

Table 2. Definitions and Excerpts – Closed Loop Manufacturing

Source	Year	Excerpt
Smith	1992	“Closed-loop manufacturing that emits no discharges, reducing customer-use patterns of toxic products, manufacturing with recyclables or choosing the least harmful materials, and more efficient products are all being considered or implemented by industry.”
Sarkis	2001	“Closed-loop or "zero-pollution" manufacturing's goal is to reuse any wastes or by-products within the manufacturing system, a micro industrial ecosystem. The success of a closed-loop manufacturing system requires both prevention (e.g. substitution) and reuse capabilities.”
Kondoh	2005	“Closed-loop manufacturing system where products are made from used products, parts and materials taken-back from market, as well as new ones, should be established.”
Jovane	2008	“Closed loop manufacturing covers everything from construction to implementation, extraction and dissolution of functionality.”
Guide & Wassenhove	2008	"Closed loop supply chain management is the design, control and operation of a system to maximize value creation over the entire life–cycle of a product with dynamic recovery of value from different types and volumes of return over time."
Morana	2011	Closed loop supply chain management deals with all forms of product return, both from unwanted products as well as from products at the end of their life.
Souza	2012	"Closed loop supply chains, which are supply chains where, in additional to typical forward flows, there are reverse flows of used products (postconsumer use) back to manufacturers. Examples include supply chains with consumer returns, leasing options, and end–of–use returns with remanufacturing. "

Operational Synergies

The practical relationship between ecodesign and the circular economy is acknowledged (e.g. Besch 2005). Importantly, a large body of literature on ecodesign practices exists including case studies, ecodesign methods, strategies and a substantial number of ecodesign tools. This existing body of practical ecodesign knowledge is beneficial to support the implementation of a circular economy.

Ecodesign strategies (such as design for recycling, design for disassembly) can facilitate closed loop remanufacturing while also making ecodesign products suited to servicing, leasing and hiring options.

This means that like the circular economy model, ecodesign often requires business model innovation to realise value invested earlier in the design stage.

Strategic Overlaps

There are strategic alliances between ecodesign and the circular economy. In general ecodesign is defined as an operational concept, whereas in our experience ecodesign requires strategic decision-making. This is because business model redesign and cross-sector collaboration are required to fully implement and therefore capitalise on benefits from ecodesign. Similarly, the core aim of the circular economy is to extract 'the maximum value from material while in use, then recovering and regenerating' waste requiring a rethink on how to design products including product systems and businesses.

Importantly, this overlap sees both concepts promote business model innovation, reverse logistics, intersectoral cascades and cross-sector collaboration. Combined, these aspects require fundamental changes in industrial infrastructure, which is a key barrier to implementation of ecodesign and circular systems.

Differing Approaches

Ecodesign is central to closed loop manufacturing and product designers are at the forefront of its implementation. While product designers play a central role, there are conflicting views regarding what this role involves. Some authors are proponents of minimisation and efficiency measures. In contrast, McDonough and Braungart (2007) have explicitly criticised resource efficiency and other reductionist techniques. Rather, through their Cradle to Cradle design protocol (C2C) they assert that eco-efficiency is at odds with long-term growth and economic prosperity. With the assumption that growth is good, the framework advocates for consumption, based on short-term product life spans. It promotes new paradigms entitled 'eco-effectiveness'' which seek to design and manufacture within closed-loop cycles. Products and product parts are made up of biological or technical nutrient materials, which are recovered and reutilised within their respective biosphere or technosphere (McDonough and Braungart 2007). Other authors have criticised the scientific basis for 'biological' nutrients and their purported environmental benefits (see Reijnders 2008).

In addition, MBDC have also criticised Life Cycle Assessment approaches, maintaining LCA can overlook certain toxicity aspects of products. Instead, they propose material toxicity testing as a preferable approach.Ideally, a combination of both approaches is desirable.

Ecodesign needs to be informed by LCA results to allow design practitioners and other stakeholders to take action. In terms of material toxicity testing, Ecodesign Centre proposes that material formulators should undertake material toxicity testing (rather than individual

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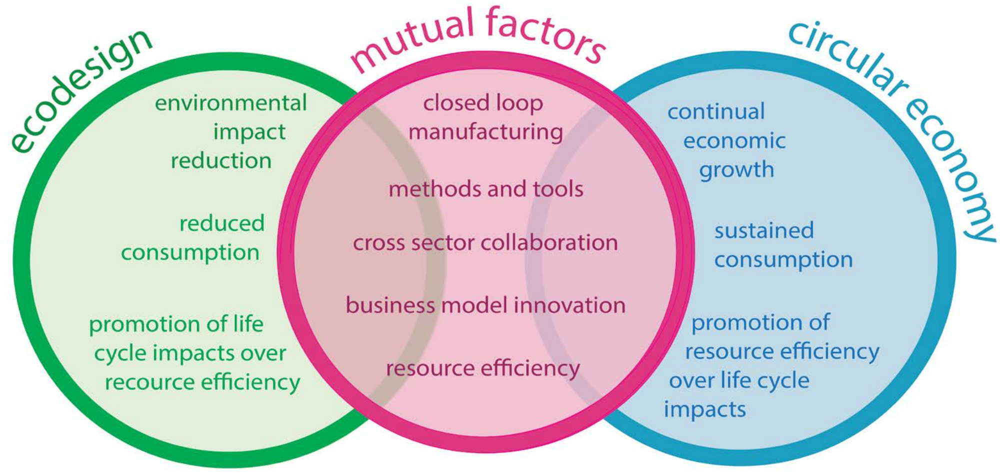

Figure 2 - Relationship between Ecodesign and Circular Economy

companies undertaking Cradle to Cradle certification on a product by product basis). Taking a twofold approach would allow for greatest environmental benefits across the product life cycle.

Fundamental Distinctions

It has long been stated that 80% of a product's environmental impacts are determined at the design phase (Graedel and Allenby, 1995). As previously discussed, Table 1 illustrates how circular economy and closed-loop definitions focus on material or resource efficiency. In contrast, ecodesign definitions prioritise total environmental impact reduction*. For example, Sherwin and Evans (2000) state ecodesign is 'the design of a product, service or system with the aim of minimising the overall impact on the environment'. This distinction is important because resource efficient products have been shown to have environmentally negative rebound effects (discussed further in Section 4).

According to McKinsey (2011) circular economics means 'meeting current demand/consumption needs' (see Table 1). In contrast, we believe society over consumes. Design has the power to fundamentally change, for the better, how society behaves and how people consume. Reflecting this, some ecodesign methods question and assess the validity of the product need, right from the outset (e.g. the LiDs wheel method).

4. Challenges to Closing the Loop

The literature discusses a number of challenges or barriers to achieving the circular economy. Here, we discuss these challenges according to three groups: challenges related to practical issues of implementation such as technical, economic and infrastructure problems; challenges to do with behavioral change; and finally fundamental challenges that Ecodesign Centre perceive within the circular economy model.

Practical issues surrounding the circular economy are frequently cited and many of these are also relevant to ecodesign. The first section discusses some of these practical problems. This is followed by a discussion of issues that are more relevant for and specific to the circular economy.

4.1 Practical Issues

Supply chain management, Logistics, Pricing and Investments

Each of the possible routes for maintaining materials in a closed system has its own problems. For example, companies struggle to implement functioning distribution networks that bring products from locations scattered nationally or internationally to a central depot. In addition, few regions have the infrastructure in place to collect unwanted products. These issues are exacerbated by a limited ability to predict quantities of returned products. Furthermore, there is often poor market demand for reused and remanufactured products, in part related to consumer perceptions of these products, their quality and functionality. Other significant problems include legally binding contracts that may constrain improvements to business operations, Intellectual Property (IP) rights which restrict information sharing along the supply chain and issues around the legalities of selling remanufactured products (Kuo 2011; Souza 2012; Vanegas et al. 2011).

In addition, the economic viability and environmental impact reduction through schemes to promote reuse and remanufacturing (such as 'product take-back') are dependent on a number of factors. Most importantly, product designs need to be durable enough to withstand remanufacturing and multiple cycles of use and Original Equipment Manufacturers (OEM) need to be willing or incentivised to take the product back at the end of its life. Leasing or rental and service models are suited to non-energy consuming products during the use phase (innovations in efficiency of energy-using products offer greater benefits for reducing environmental impacts). Products also need to be manufactured with standardised materials to generate high value and pure recyclate thus incentivising product take-back (Kuik et al. 2012; Grant & Banomyong 2010). Some businesses may have also already invested large amounts of money in machinery and infrastructure for their production processes, making required changes uneconomical. Others may struggle to raise initial investment funds to implement improvements.
Businesses also need appropriate financial models to market remanufactured products. This is an active and complex area of academic research in its own right (e.g. Liang et al., 2009; Shi et al., 2011). One particular

*For a review of ecodesign definitions see Envisioning Ecodesign: Definitions, Case Studies and Best Practice: http://www.ecodesigncentreorg/en/resources/envisioningecodesign-definitions-case-studiesand-best-practice issue is known as the 'cannibalisation' effect. This occurs when consumers who previously bought new or first-life products from a business, switch to a lower price remanufactured one (purchased from the same business), and in doing so put that business in a profit risk scenario.

Recycling and Externalities

Economic, infrastructure and technical factors also influence the viability of recycling for some materials. For example, although technically possible, it is difficult and uneconomical to perform closed loop recycling for some types of plastic due to the mixing of contaminants such as ink and metals in the recyclate (Hopewell et al., 2009). Therefore, plastics are often down cycled into products that require a lower quality material. There are also challenges for the recovery and recycling of metals. While efficient recycling processes currently exist for metals such as aluminium and steel, the recovery rates for other metals such as Rare Earths are much lower (Ecodesign Centre Critical Materials Briefing*). Challenges to the recovery of these metals include very low quantities in products, making it difficult to develop economies of scale, and trade-offs between the recovery of one metal type versus another in the recovery process (Hagelüken & Meskers, 2009). A major challenge is ensuring that metals from waste products enter into the correct recycling pathways. Currently a large quantity of end-of-life products are traded abroad and processed inefficiently, sometimes at high costs to the environment and human health.

Andersen (2007) suggests that the circular economy cannot recycle materials in perpetuity, noting that beyond a certain point recycling will become too difficult and burdensome to result in a net benefit. This is in part related to a problem with the true cost of goods and services where the external costs to the environment or 'externalities' are not included. This results in goods and services being priced very cheaply, making recycling and reuse of materials uneconomical while virgin material supplies are still plentiful. This phenomenon prevails despite the environmental impacts associated with their production.

For these reasons ecodesign prioritises long life durable products that can be reused or efficiently remanufactured with limited additional process. This is particularly important because easily disassembled products with high amounts of recycled content (therefore suited to recycling) can often have compromised durability (Prendeville 2014).

Behavior Change Issues and Overconsumption

Achieving a circular economy requires action from and communication between a variety of stakeholders including politicians, business managers, investors, research scientists, designers and everyday consumers. Changing current modes of production and consumption requires behavior change

*Ecodesign Centre Critical Materials Briefing available at: http://ecodesigncentre.org/en/resources/ecodesign-centre-critical-materials-briefing-document amongst these groups. A large amount of research has been undertaken on pro-environmental behavior change (Lucas et al., 2008; Steg & Vlek, 2009). One major challenge is altering peoples' habits to avoid activities that are unsustainable (Kollmuss & Agyeman, 2002). On a business level, change also requires leadership from owners and managers.

Of particular concern in the literature, linked both to general consumers and businesses, is the occurrence of certain rebound effects associated with resource efficient products (Souza 2012). Resource efficient products have been shown to lead to increases in consumption, known as the Jevons Paradox, and therefore greater cumulative environmental impacts (Polimeni et al., 2009) . Discussing these phenomena with an economist uncovers that resource efficient products are beneficial, up to an optimal point, after which little or no additional benefits are gained. Therefore, focusing solely on resource and material efficiency in products, threatens the sustainability of the circular economy.

More Fundamental Challenges to the Circular Economy

There are also limitations to recycling and growth of the economy based on material use that can be understood from the second law of thermodynamics (Ayres, 1998). This law recognises that entropy (a measure of disorder) in an isolated system always increases until it reaches a state of thermodynamic equilibrium (maximum entropy). If the economy is considered as a closed thermodynamic system [1], then materials cannot be cycled continuously without inputs of energy external to the system.

In the short-term limits to economic growth based on thermodynamics will not be an issue. Supplies of many materials currently remain plentiful. However, rapid economic growth that is decoupled from environmental degradation may be limited by the environmental damage caused by mining materials and an inability to source clean, renewable energy at competitive prices. In the longer-term thermodynamic limits may mean that the circular economy alone will not be a solution for a truly sustainable society.

5. Alternatives to the Circular Economy

There are other economic models that have been suggested that are less supportive of economic growth, due to the limitations described above. But also because there is evidence to suggest that beyond a certain point economic growth based on material use does little to increase human well being (Jackson, 2009). Perhaps the most frequently cited alternative model is the steady state economy, where the size of the economy is stable. For a steady state economy to be achieved the throughput of materials in an economy would need to remain fairly constant, as would population. A limit would then have to be set on resource inputs to allow for a level of economic activity that ensures good

1.Earth is a closed system but not an isolated system; energy inputs can come from the Sun

There is evidence to suggest that beyond a certain point economic growth, based on material use, does little to increase human well being (Jackson, 2009).

living standards for the population while maintaining the natural environment. Innovation and resource efficiency measures may then allow for continuous improvements in quality of life to be made.

The other commonly cited suggestion is sustainable degrowth. As the name implies, this model aims for planned degrowth of the economy to ensure society lives within environmental limits. While often considered as different from the steady state economy, some commentators see the end route of sustainable degrowth as a steady state economy (Kerschner, 2010).

Moving towards a steady state economy or achieving sustainable de-growth both represent major challenges for society. One of the largest barriers for either is the fact that population would have to remain constant or decrease. Currently population is predicted to rise, reaching around 9 billon people by 2050 (United Nations, 2004). It is also difficult to see how resource inputs into the economy could be limited and controlled on a global scale and is important to note that many countries still need economic growth to lift them out of poverty.

Despite these challenges, a steady state economy has long been suggested as the endpoint of development of an economy (Kerschner, 2010). Although it may be some way off, a steady state economy should perhaps be a goal to strive towards. The circular economy could be used as a route to achieve this. Despite it being a concept that is supportive of economic growth, a circular economy implemented using ecodesign principles will allow for better quality of life while reducing environmental degradation. These changes may make it easier to achieve a steady state economy in the future, while being less at odds with political and economic systems of the present.

6. Conclusion

This brief paper discusses the circular economy model from the perspective of ecodesign. In doing so, Ecodesign Centre sets out important issues that need to be addressed to ensure environmental and social sustainability within a circular economy model.

We believe promoting resource efficiency to industry, coupled with advocating for continual economic growth and consumption, poses long- term risks to the environment and to society. And therefore risks the sustainability of the circular economy.

The proven success of the circular economy model is its ability to awaken and mobilise industry. It is clear that the circular economy is instrumental to drive forward necessary societal changes in modes of production and consumption. With greater alignment of environmental issues, the circular economy model offers unparalleled opportunity for societal transition.

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