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Towards Ecological Management: Identifying Barriers and Opportunities in Transition from Linear to Circular Economy

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Abstract

This article will discuss the concepts of Cradle to Cradle and Circular Economy in relation to sustainable production involving philosophical debates on economic growth, and the risk of subversion of managerial practice to business as usual. The case study is based on the assignments submitted by Masters students as part of a course related to sustainable production and consumption at Leiden University in The Netherlands. Some of the supposedly best practice cases placed on the website of the Ellen MacArthur Foundation or those awarded Cradle to Cradle certificate were evaluated by students as green-washing. Larger implications of circular production for business and ecological management are discussed.

Keywords Circular economy · Cradle to cradle · Green-washing · Ecological management

Introduction: Circular Frameworks

One of the key developments in the area of sustainable production is the cradle-to-cradle (C2C) framework (McDonough and Braungart 2002). This book is inspired by the fields of industrial ecology (Frosch and Gallopoulos 1989) and ecological management that stimulates learning from nature, instead of using it as a mere resource to be consumed (Daly and Farley 2004). As discussed in this book, there are a number of fundamental problems with the current system of ‘cradle to grave’ production, which supports management practices that focus on economic benefits. This results in manufacturing of cheap consumer goods that are actually made *not* to last – the concept known as planned (or built-in) obsolescence (Bulow 1986). Since producers are interested in constant sales, built-in obsolescence makes repair or reuse economically unattractive. Within this logic, managing sustainable business came to signify *reduction* in harm, rather than *complete elimination* of resource-depleting production. ‘Waste to energy’ power production, for instance,

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which is touted as sustainable, makes valuable mixed materials literally go up in smoke for a short surge of energy (Braungart 2013). While burning garbage to produce energy may be seen as efficient use of resources, it is not effective in the long run as biomass is being slowly destroyed.

Also, many products are made with the idea of ‘one size fits all’ (e.g. standard buildings constructed without taking into consideration local climatic conditions or materials), ‘brute force’ or toxic materials used such as bisphenol A or BPA, an industrial chemical shown to interact with the body’s endocrine system (Cooper et al. 2011), ‘culture of monoculture’ (e.g. palm or soya plantations) and ‘monstrous hybrids’ (e.g. an average juice container is made of different kinds of plastics, carton, and glue and does not have easy-to-disassemble parts) (McDonough and Braungart 2002). Many packaging materials could potentially last for hundreds of years and yet most packaging disposed of after the product is taken out (Davis and Song 2006). McDonough and Braungart lament the rise of the monocultures and the fact that diversity is ‘typically treated as a hostile force and a threat to design goals’ (2002:32–35).

By contrast to the styles of management that used to encourage such wasteful production, C2C in management would seek to utilize differences of the soil and climate, materials, and local knowledge (McDonough and Braungart 2002). Rather than create prosperity by “digging up or cutting down natural resources and then burying or burning them” and “eroding the diversity of species and cultural practices” (McDonough and Braungart 2002:18), C2C seeks to create a system of production which is actually beneficial to environment. Following this, responsible innovation and ecological management considers ethical issues associated with production processes that not only are profitable but also environmentally sustainable as well as socially desirable and acceptable (Klikauer 2014; Attfield 2015; Blok 2018). Thus, ecological manager or advisory team needs to have knowledge of geographic differences and conditions. Ecological knowledge of the manager can also help create products that follow C2C design principles, targeted at enhancing rather than depleting natural environment.

These principles, applied to business, imply that ecological management needs to emphasize effectiveness, and not just efficiency. While we are used to managers being affective in practices ranging from the use of information systems to human resources, the new type of ecological manager is more humble. Klikauer (2014) argues that the deep ecology environmental ethics requires a total image of humanity as a mere element of a larger environment, and that application of this philosophy in business requires a very different role for the manager. He or she reminds us of the limitations to the right to manage and of the management of resources on others’ behalf for “what is intrinsically valuable, and responsibilities not only to owners but also towards present and future people and other creatures” (Attfield 2015:85).

Efficient manager in this case follows the path of responsible innovations such as C2C and supports bold moves beyond mere minimizing of the damage by ‘slowing the process of destruction’ ptimising products that should not be there in the first place (McDonough and Braungart 2002). Instead of ‘making a bad design last longer’ – as, for example, electric cars still rely on fossil fuel –and just causing the rebound effect (e.g. Isenhour 2010; Kopnina 2016), C2C proposes being ‘all good’ (Genovese et al. 2015).

Ecological management that embraces this understanding needs to stimulate redesign of products in such a way that they can be not merely recycled (which is basically downcycling, whereby the product returns to the technical metabolism ‘at a lower level’) but *infinitely reused*. Ideally, products that can be infinitely re-used can be an example of absolute decoupling of economic growth from resource consumption. However, in reality, absolute decoupling is problematic (Fletcher and Rammelt 2017), especially given growing material demands and increasing population (Washington and Kopnina 2018). As Fletcher and

Rammelt (Ibid) further argue, “decoupling serves to sustain faith in the possibility of attaining sustainable development within the context of a neoliberal capitalist economy that necessitates continual growth to confront inherent contradictions”. In this context, the popular concept of “eco-efficiency” can be seen to make more efficient the system that is essentially based on increased consumption of resources.

At best, as in the case of food consumption, attempts at decoupling slow down the rate of depletion without completely eliminating the need for virgin materials (Rammelt and Crisp 2014). Worse, in the context of growing population and increased material demand, absolute decoupling appears to be wishful thinking that allows business-as-usual to continue (Burton 2015; Fletcher and Rammelt 2017). Indeed, focusing on the dream of absolute decoupling runs the risk of becoming part of the denial of the unsustainability of endless growth (Washington and Kopnina 2018). As Fletcher and Rammelt (2017:450) state, ‘decoupling fantasy’ functions to “obfuscate fundamental tensions among the goals of poverty alleviation, environmental sustainability, and profitable enterprise that it is intended to reconcile”. Indeed, trying to reconcile the increased need to produce and fairly distribute natural resources on the one hand and the need for environmental sustainability on the other hand, ecological management needs to avoid deceptive ‘have your cake and eat it too’ solution. Thus, ecological management needs to also confront the basic mechanisms of ravenous industrial development system that requires continuous supply of resources.

The deeper philosophical issue associated with economic growth is that it is exactly this economic paradigm that is at odds with the challenge of environmental problems as well as inequality issues. Indeed, the imperative of economic growth may be ‘responsible’ for resource depletion and thus the question of ‘responsible’ innovation or management within the same economic paradigm becomes suspect (Blok 2018). Braungart and McDonough (2009:3) emphasize that the current plundering of resources in the name of economic growth has disastrous consequences for all species.

Related to these concerns, this article inquires: Do current practices labeled as C2C or CE meet the ambitions (or promises) of these movements? Is it possible to have completely CE or C2C products? What is the effect of business-as-usual practices on new environmental sustainability movements? How much of actual decoupling is technologically and economically viable? After discussing the ideals of C2C and CE in the section below, the case studies illustrating the danger of subversion to economic objectives will be addressed.

Origins of the Circular Economy (CE)

CE originates from the inference that the economy and the environment should coexist in equilibrium (Boulding 1966) - the concept known as ‘self-replenishing economy’ (Stahel and Reday-Mulvey 1981) or the Performance Economy (Stahel 2006). CE is defined as a “regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, narrowing, and ideally entirely closing material and energy loops”. This is achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling (Geissdoerfer et al. 2017). Thus, new circular thinking goes beyond churning out even more ‘sustainable’ products but re-using materials that are already there. This economy requires the ‘product service shift’ (PSS) through transition from selling a product to renting it through leasing contracts (pay-per-use instead of ownership). Stahel (1984) added an economic motivation stressing that product life-extension services such as monitoring and repair should lead to an increase in job creation. Murray et al. (2017:371)

defined CE as ‘an economic model wherein planning, resourcing, procurement, production and reprocessing are designed and managed, as both process and output, to maximize ecosystem functioning and human well-being’.

C2C is critical of eco-efficiency as it emphasizes only partial or relative decoupling and fails to reimagine the destructive practices of industry and merely allows them ‘to take place in smaller increments over a longer period of time’ (Braungart and McDonough 51; 54). In fact, eco-efficiency makes a destructive system appear ‘less bad’, yet essentially allows industry to ‘finish off everything, quietly, persistently, and completely’ (Braungart and McDonough 2009: 62; 65). Ecological managers need to reach out to a wider society to ensure that ‘environmental, social, and cultural concerns’ are afforded due consideration ‘at the outset’ of production rather than as an afterthought when waste is already generated (ibid: 150; 153).

Recent strategies maximizing of products’ lifespans and the reusability such as Design for Recycling, Design for Disassembly, and Design for Remanufacturing have emerged (Kopnina and Blewitt 2018). These strategies are crucial at the design stage of the manufacturing process and not just at the end when waste is already produced. Most products presently on the market are designed with planned obsolescence in mind (Bulow 1986).

The C2C framework is based on the ideas of cycles of either biological (biodegradable textiles, for example, can be used as compost) or technological “nutrients” (synthetic material that can safely in a closed-loop system of manufacture, recovery, and reuse). While biological cycles include organic waste that can be used for fertilization of the soil, for example, technical nutrients can be most often used for high quality products that can be leased, with manufacturer retaining ownership (McDonough and Braungart 2002). Thus, be it organic material containers for collecting organic waste like autumn leaves, or green funerals in which the grave serves literally as a cradle for formation of new soil, production strategies that utilize ecological cycles can be called truly green (Kopnina and Blewitt 2018). C2C aims to eliminate waste by ensuring production uses materials that can be of “nutritional value” for either biological or technological cycles. Like C2C, circular economy (CE) aims to decouple economic growth from the increased use of natural resources through utilization of these cycles. Thus, CE is seen as a way to both minimize the waste-flow, and limit and ideally keep constant the amount of resources extracted.

This requires material and waste management that not only effectively manages natural resources by radically reforming the system of production, but also recognizes intrinsic values of the natural world. In urban planning, for example, circular systems can allow for different species to share space with human inhabitants, embracing an ethics of conviviality that is emplaced and enlivened (Van Dooren and Rose 2012). For example, green buildings with plant-overgrown walls and roofs (e.g. Oberndorfer et al. 2007) are both safe and clean for human residents but also open to insect and bird species (e.g. Wang et al. 2017). The ecological management of such green buildings includes ‘natural’ management by the building itself that regulates storm-water flows and ventilation (e.g. Oberndorfer et al. 2007) as well as ‘management’ by other species that fortify the walls for building nests. More generally, the concept of CE offers a new perspective on waste and resource management to extend the productive life of resource (Blomsma and Brennan 2017).

It needs to be underscored that this radical transformation is just an aspiration, which has yet to be fully understood and supported by regulators, designers and the consumers. Transition to circularity requires nothing less but profound institutional and cultural changes as well as shared understanding and transparency between governments, corporations, and consumers (Kopnina and Blewitt 2018). Optimistically, introducing new forms of ownership and material

management can be balanced against the lucrative opportunities as a true potential to reap social and environmental benefits. Pessimistically, as much else in the field of marketing, the noble aims can be subverted to the one and only former benefit – lucrative opportunities, forgetting sustainability.

The Risks of Subversion to Business-as-Usual

Ideally, transition to circular economy requires nothing less than radically re-designing industrial systems. The Ellen MacArthur Foundation, a charity founded in 2009 aims to provide a platform to re-think, re-design & build production system through the framework of a circular economy, lists companies on its website that supposedly provide cases of best practices. In popularizing and globalizing CE's appeal, the Foundation develops courses that stimulates innovation and encourages corporations, educators, and policymakers to follow best case studies of successful transitions. The corporate reports proudly highlight a trillion dollar opportunity in net material cost savings for businesses making the transition (www.ellenmacarthurfoundation.org/business/).

The Cradle-to-Cradle certification spans over five different categories (material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness) and five different levels (Basic, Bronze, Silver, Gold, Platinum). A product receives an achievement level in each level with the lowest achievement level representing the product's overall mark (Cradle to Cradle Certified 2014). For example, products certified at the Gold level are required to use at least 50% renewable electricity and offset at least 50% of greenhouse gas emissions associated with the final manufacturing stage (Kausch and Klosterhaus 2016). Platinum certification is supposed to offset 100% emissions. Yet, if strict assessment criteria are applied, few Ellen MacArthur Foundation's case studies appear to be really "best practice" (Kopnina 2017, 2018).

C2C and CE may overestimate the potential to close cycles of 'technical nutrients' if these circles keep expanding due to a growing population and material demands (Rammelt and Crisp 2014). The shift to 'biological nutrients' for anything from packaging to dealing with the actual human waste after eating, given population growth and current and growing consumer demand, require even more land to produce these materials. CE and C2C may be too optimistic about the physical basis such as food for seven and a half billion people (Kopnina and Blewitt 2018). If non-plastic packaging is used, for example, the wider monitoring of the sustainability of biomass needs to be considered (Pavanan et al. 2013). Thus, circular economy in business needs to be understood as most effective in the context of degrowth or drastic limitations to consumption (Isenhour 2010; Rees 2010; Washington 2015). The type of ecological management needed includes leadership in transition to service economy but also in the focus on not just producing new products, but making do with what we have.

Economic motivation in adopting circular economy still tends to dominate state policies. For example, facing significant natural resource consumption, environmental degradation, and resulting public frustration, the Chinese government adopted the circular economy as a new strategy for development in 2002. The initiative was framed as part of ecological modernization, green (low carbon) growth to stimulate continuous economic growth (Geng et al. 2013; Ghisellini et al. 2016).

While responsible innovation and ecological management have huge transformative potential, the words 'management' and 'innovation' have traditional connotations associated with

economic efficiency. These “technological fixes” risk obfuscating the need for fundamental changes to our economic model (Rees 2010: 2) and leave ‘ecology’ subservient to innovation, still treating nature as a resource (Crist 2012).

The cases below address the challenges of C2C or circular economy to drinking bottles. These bottles are intended to substitute for one-time-use Polyethylene Terephthalate (PET) bottles. PET, a synthetic plastic made from the polyester family, only has 10% recovery and recycling rate globally (Green 2015). There are thought to be 50 billion single-use PET bottles produced annually (Ban the Bottle 2016). PET bottles are what Braungart and McDonough (2009: 37) refer to as ‘crude’, ‘unintelligent and inelegant’ products that have not been ‘designed particularly for human and ecological health’. Pierre-Louis (2012: 88) states that four-fifths of plastic water bottles produced for the US market end up ‘in some combination of landfills and the world’s ocean’.

Case Studies

The case studies below are based on the assignments submitted between 2016 and 2017 by Masters students as part of Environment and Development course at Leiden University in The Netherlands. The author was involved in coordinating and teaching of this course. One of the subjects discussed in class was critical evaluation of supposedly best practice case studies from the website of the Ellen MacArthur Foundation. The students were asked to write an essay of the subject of C2C and/or CE product, evaluating it as a “best practice” or green-washing. Below, cases of Coca Cola, The Doppet, the The Klean Kanteen (KK) are discussed and comparison is made between conventional plastic, biodegradable, and partially biodegradable bottles.

“Plant Bottles”

The Coca-Cola has been placed on the list of best case studies of Ellen MacArthur Foundation. With much fanfare Coca-Cola has pioneered the so-called “Plant Bottles” which are supposedly on the way to make the company circular, as advertised on Ellen MacArthur’s website. Coca-Cola uses sugarcane and waste from sugarcane manufacturing to create PlantBottle (Arthur 2015). Since 2009 Coca-Cola has been using a version of Plant Bottle made from fossil-fuel based terephthalic acid and up to 30% plant-based MEG (Arthur 2015). The Plant Bottle available on the market, however, is actually made of up to 30% plant material, with the rest being non-organic material.

The students also found that Coca-Cola’s operations present a case of window-dressing masked by clever ethical branding boosting corporate reputation (Fan 2005; Holt 2012). Without addressing the Coca-Cola’s considerable water footprint (Hills and Welford 2005), and its plastic packaging (Balch 2011), the company seems eager to advertise itself as “circular”.

The Doppet

The Doppet Original is a certified “Bronze” C2C product. The colored Doppet base and cap are made from Polypropylene (PP), the white shiny neck is made from Acrylonitrile Butadiene Styrene (ABS) (Preserve 2016b), and the ridges around the rim are made from Thermoplastic

Elastomers (TPE) (How it's Made 2014). It does not contain toxic substances like antimony or BPA (Preserve 2016a). It also endeavours to reduce plastic waste as its thermoplastics are in principle 100% recyclable (Dopper 2015d). Dopper states that through donating 5% of its net turnover to the Dopper foundation, 18,000 people in Nepal have access to clean water, thus contributing to social welfare (Dopper 2015e). However, the company does not specify what percentage of the bottles is made from recycled PP or old Doppers. Although the Dopper claims it is “produced with responsible water and energy use” it only received a Bronze for “Water Stewardship” (Cradle to Cradle Certified 2014).

While Dopper raises awareness about the impact of single-use plastic, the company is not highlighting the essential links between consumption and environmental degradation. A quote from a customer reflects this problem: ‘The Dopper is our handiest bottle! We have five of them’ (Dopper 2015b). The Dopper embodies the current emphasis on lifestyle choices and does not address issues of corporate and political regulation (Isenhour 2010).

Klean Kanteen (KK)

The Klean Kanteen (KK) is a BPA-free water bottle made from stainless steel containing 18% chromium and 8% nickel, while the cap is made from silicone and bamboo (Klean Kanteen 2016a, 2016b, 2016c). The bottle has a lifetime guarantee due to steel's lasting durability. Although KK states: ‘sustainable business is one that gives more than it takes’ (Klean Kanteen 2016c), and despite stainless steel being one of the easiest materials to recycle, KK bottles are made entirely from virgin steel (Pierre-Louis 2012: 93). Although nickel and chromium are naturally abundant, nickel is mined in open pit mines that have a devastating long-term impact on the environment (ibid). The chromite ore is mined in South-Africa, Kazakhstan, Russia, and India (Materials World 2015). In India, chromite miners develop health problems as well as birth defects and stillbirths as a result of overexposure to ‘contaminated dust and water’ (Das and Singh 2011).

Comparison of Materials

Material Input per Service Unit is a method of assessing the environmental impact throughout the life cycle of a product or service (Rithoff et al. 2002). This was used for comparing the environmental impact of the different materials, as shown below in Table 1.

The first row of the table compares the amount (in kilograms) of oil, water, and greenhouse gases that are used and emitted to produce one kilogram (kg) of each of the bottles’ materials (PP, ABS, SS, PET). The second row calculates the material used for one bottle. KK has the greatest environmental impact as it uses 44.19 kg or liters of water to make one stainless steel bottle, over double the amount used to make one Dopper and over 15 times the amount needed to make one PET bottle. Like the Dopper and KK, production of PET bottles relies on oil and gas, but the fact they are designed for single usage makes them a particularly wasteful.

The final row compares the amount of resources used to make one Dopper to the two other bottles, revealing that the amount of oil needed for one Dopper could make over 5 PET bottles but only 13% of a KK bottle. Similarly, the amount of water needed for one Dopper could make 7 PET bottles but only a 47% of a KK bottle. Therefore, when one only examines the materials, PET bottles have the lowest impact on the environment. Also, some materials in the Dopper are ‘monstrous hybrids’, combining both technical and organic materials that cannot

Table 1 Comparing the environmental impact of the different materials

Water bottle		Dopper			Klean Kanteen	Single-use bottle
Material		PP	ABS	Total bottle	SS	PET
Weight (grams)		72.00	28.00	100.00	215.40	12.70
Kg/1 kg Material	Oil	4.24	3.97	8.21	14.43	6.30
	Water	205.48	206.89	412.37	205.13	230.00
kg/Bottle	GHG	3.37	3.75	7.12	2.83	3.50
	Oil	0.31	0.11	0.42	3.11	0.08
	Water	14.79	5.79	20.59	44.19	2.92
	GHG	0.24	0.11	0.35	0.61	0.04
1 Dopper vs. Others	Oil			1.00	0.13	5.20
	Water			1.00	0.47	7.05
	GHG			1.00	0.57	7.82

be easily separated, thereby rendering it unable to be reused by either system (McDonough and Braungart 2002). However, this does not take into account the fact that PET bottles are meant for single use and thus repeated use of the Dopper would be a better use of resources than the other bottles.

Manufacturing Process

The Dopper is manufactured in a similar manner to PET bottles, albeit at a much slower rate. The Dopper machine produces 120 bottles an hour (How it's Made 2014). The PP lid and ABS cup are injection molded and the PP bottle is injection molded into a pre-form and then blow molded into the correct size and shape (How it's Made 2014). Electric injection molding machines use between 30% and 60% less energy and up to 65% less water than hydraulic machines (Tangram Technology 2014). However, from an eco-effective perspective, such reductions only make the process 'less bad' rather than actively good (Braungart and McDonough 2009: 65).

The Dopper is produced in the Netherlands and people can buy bottles online and from 550 sales outlets. Its American partner, Preserve, helps Dopper offset the emissions produced from shipping to the US (Preserve 2016b). However, there is no further information about how this is done and whether all emissions or just a percentage are offset. The Dopper is also shipped to 24 other countries and it is not specified whether these emissions are also offset (Dopper 2015a).

Klean Kanteen bottles are 'hand crafted' in China. The steel body is welded together by hand, shaped to the required size using machinery, and 'electro polished' for a sleek finish (Hogan et al. 2014). The company buys Renewable Energy Certificates, equivalent to '88,000 kWh of Renewable Energy', from its partner 3Degrees that offset the environmental impact of their electricity use during manufacturing (Klean Kanteen 2016a).

All online orders are shipped by truck via UPS Ground in the US. One cannot purchase a KK online outside of US. Klean Kanteen (2016b) works with its partner, Green Mountain, to purchase carbon offsets that balance out the environmental impact of shipping. However it is not clear whether the impact of transporting the bottles from the factories in China to the headquarters in Chico, California is also offset.

Recycling

Braungart and McDonough (2009: 104) argue that industry should design products to be nutrients for biological and technical metabolisms rather than them ending up as waste when people no longer have need for them. Doppers that are returned to the company will be recycled into new Doppers, which suggests they could be seen as a technical nutrient. However, although the Dopper is easily disassembled and 100% recyclable, #7 plastics are a mixed group of plastics that are usually downcycled into plastic lumber (Life Without Plastic 2015). Even PP can only be ‘recycled in a ‘closed loop’ four times’ before the polymer chains weaken from exposure to high temperatures during recycling (Thomas 2012). At this point, the plastic will either be landfilled or mixed with other plastics during recycling ‘to produce a hybrid of lower quality’ (Braungart and McDonough 2009: 56). Yet, over the period of time, the Dopper’s materials end up wasted, so its life cycle is “four steps removed” from cradle-to-grave (ibid: 6). Also, as virgin plastic is always added to the recycled content, the Dopper continues to rely on oil and gas (Pierre-Louis 2012: 93).

In contrast to materials used for Dopper, steel can be recycled an infinite number of times without its quality degrading, and can thus continually nourish technical cycles of industry (Braungart and McDonough 2009: 5). If stainless steel was made from 100% steel scrap, ‘energy use would be 67% less than virgin-based production and CO₂ emissions would be cut by 70%’ (Johnson et al. 2007: 1). Recycling steel allows valuable metals to be reused. However, due to the longevity of steel products currently ‘in service’ there is an inadequate amount of steel scrap in recycling streams (American Iron and Steel Institute 2016), which is not enough to satisfy growing demand. This may explain why KK is not in a ‘closed loop’ cycle.

PET bottles are made from similar polymer resins that lend themselves to injection molding and ‘reprocessing to polyester fibre’, which results in PET bottles being ‘recycled in a strictly closed-loop fashion’ (Hopewell et al. 2009). Yet, Braungart and McDonough (2009: 6) argue that reprocessing plastic bottles into polyester fibres used for synthetic clothing merely delays the cradle-to-grave life cycle, as the clothing eventually ends up in landfill (ibid: 6). While C2C favours products that can be reused or upcycled, downcycling is still preferable to products ending up on landfill (ibid: 171).

However, production of bioplastics can compete with food production and biodiversity (Vidal 2008); and also there is inadequate infrastructure for recycling bioplastics as they end up in landfill (Szaky 2015). Another issue is that PLA has a ‘low glass transition temperature’ of between 40 and 60 degrees Celsius, which means bottles would ‘deform’ in hot weather or hot water (Rogers 2015).

Reflection

In sum, these case studies show that aspiring companies still focus *not* on elimination of damage and re-use but on *minimizing* of damage, *recycling*, and eco-efficiency. For example, Dopper’s claim that it ‘contributes to reducing the global plastic problem’ (Dopper 2015c) is paradoxical as it does this by producing plastic bottles from virgin materials. While KK prides itself on being “plastic-free”, it relies on the mining of virgin metals. However, Braungart and McDonough (2009: 171) argue, we cannot afford to wait for “the perfect bottle”. Thus, the

Dopper, as a product ‘made with care and consciousness’ from materials that use less oil than steel and can remain useful for four closed-loop technical cycles, is better than PET bottles and KK.

The cases of drinking bottles indicate that conventional and short-term thinking in terms of immediate costs can prevent fundamental revision of business. Some of the practices described in the case studies above testify to green-washing rather than to genuine efforts to promote fundamental change in production. While companies such as Coca Cola or other bottle producing companies improve one part of their operation, they fail to overhaul of the entire supply chain, mode of operation, or change product materials from the start, as well as how the final products are transported, packaged, and disposed of. This example shows that ‘simple and easy’ approaches to circularity may suggest subversion of the original aims of C2C/CE transformation.

From the examples above it appears that some of the current practices labeled as C2C or CE do not meet the ambitions (or promises) of these frameworks. While it is possible to have 100 % CE or C2C products, it might be expensive or technically challenging. It is likely that 100% vegetable-based substitute is difficult to make due to price (as making it will require organically grown crops that compete for land with food crops) and convenience (e.g. fully biodegradable bottle might not be as strong for transportation and retail as plastic one). Besides, environmental considerations also need to be considered (e.g. the need for even more monoculture plantations to make new bottles) may misplace even more wild and pristine environments. Considering the huge scale at which Coca-Cola produces its bottles makes production of new, virgin material bottles all the more problematic. Indeed, in the United States over 17 million barrels of oil are needed for the plastic bottles’ production (Green 2015).

This does present serious concern about the effect of business-as-usual practices on the environmental sustainability movements that present themselves as new, disruptive, or radical. Continuous production of “sustainable” products is likely to result in the rebound effect, and continuous economic growth at the cost of environment. It remains challenging to achieve maximum technologically and economically viable decoupling (Burton 2015).

One needs to keep questioning whether, with the right political will, relative decoupling could proceed fast enough to achieve real reductions in throughput, allowing for continued economic growth, and whether this economic growth is desirable in the first place (Bauwens 2018). Even the founding fathers of the C2C are not immune to the appeal of “growth” and do not think that we should strive for ‘zero impact’ (Braungart and McDonough 2009: 66–7). Braungart and McDonough (2009: 11) argue that “unlimited growth” does not have to be destructive: ‘Cradle to Cradle goes beyond the environmental chorus saying that growth is wrong and that it is virtuous to prune the pleasures we take in things like cars or shoes until there is no pleasure left’ (ibid). This optimistic outlook bypasses consumers’ attempts to “buy less” or “buy none” (Isenhour 2010: 460), and does not challenge population growth and “Western way of life”.

As Crist (2012) has reflected, the heavy footprint of the growing consumer class coupled with the ethical aim of raising the standard of living of the world’s most poor people, translates not only into the worthy aim of ending severe deprivation, but serves as a euphemism for the global dissemination of consumer culture. Even renewable resources are being consumed ‘at a rate 50% higher than can be produced sustainably’ (Population Matters 2013). As Rammelt and Crisp (2014), Rees (2010) and Washington (2015) argue, the growth paradigm knows no ecological bounds. Thus the idea that ‘human ingenuity will find a substitute for any depleting resource’, which C2C could be seen as supporting, merely allows the ‘expansionist myth’

based on the idea of decoupling to continue (Rees 2010:5). In reflecting on the idea of decoupling natural resource consumption from economy, Victor and Jackson (2015) note that while there has been some ‘relative’ or partial decoupling’, any absolute decoupling is not evident.

The following “R” actions need to be considered in pragmatic planning (Table below adopted from Bauwens 2018):

Circular economy	Increasing circularity	Strategies	
		R0 Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product
		R1 Rethink	Make product use more intensive (e.g. by sharing product)
		R2 Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
		R3 Reuse	Reuse by another consumer of discarded product which is still in good condition and fulfils its original function
		R4 Repair	Repair and maintenance of defective product so it can be used with its original function
		R5 Refurbish	Restore an old product and bring it up to date
		R6 Remanufacture	Use parts of discarded product in a new product with the same function
		R7 Repurpose	Use discarded product or its parts in a new product with a different function
		R8 Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality
Linear economy		R9 Recover	Incineration of material with energy recovery

In the case of bottles above, the first two Rs, Refusal and Rethinking, is questionable, as most of the bottles are unlikely to be used endlessly or be shared by consumers, with growing number of consumers and growing demand for “sustainable” bottles implying that resource-intensive manufacturing of bottles is likely to continue. What is present is the third R, Reduction, but in ‘ideal’ CE/C2C framework reduction can be seen as more akin to eco-efficiency, which is not good enough for absolute decoupling. Some types of bottles do involve Reuse, Repair and Refurbishment, but the core business of KK, Dopper and certainly Pant Bottle of Coca-Cola remains production of new bottles.

Returning to the questions posed in the Introduction in relation to ecological management that might have a potential to challenge growth myths, ecological manager needs to take heed from the warnings that resources, however produced, if consumed by a large number of people, will be eventually depleted. Drawing on the Greek root of the ‘economy’, oikonomos, Haydn Washington (2015) reflects that it is derived from oikos, ‘house’ and nemein, ‘to manage’. ‘Good’ economics should be good management of the home, which consists of ecologically sound systems. However, Washington (2015) notes, modern economics and management are fraught with issues of economic worldview as well as ignorance and denial of ecological reality.

Linking this back to the cases drinking bottles, the production of neither KK, nor Dopper nor Plant Bottle shows a shift toward a system that will be replenishing, not just to the producer’s purse, but to a natural system. Ecological management then needs to include eco-justice for nature, and its intrinsic value and rights (Washington 2015) as well as deeper

understanding as to how innovative designs can contribute to restoration of the system. Even though C2C Certified products may still be environmentally preferable when compared directly against conventional products or across a broader array of indicators, ‘Gold’ certified C2C products achieve only 50% fossil-fuel reduction (Kausch and Klosterhaus 2016), which is far from perfect.

Most promising are the products and services where ‘circularity’ can be reached through continuous re-use of durable products made of non-toxic materials. This objective can be realized by production to service shift (sharing the same good quality washing machine which is owned by the company, leased to consumers, and can be almost entirely repaired and refurbished as its parts are reusable after the customers have returned the ‘old’ model after prolonged and repeated use).

Ecological management also requires honest understanding that production of any new parts for refurbishment or repair, or the growing number of consumers, does require new material input and thus can be harmful to environmental systems. As none of these bottles fully reflect the C2C ideals, it is worth considering some alternatives. For example, Polylactic Acid (PLA) is a durable bioplastic made from renewable sources such as tapioca, cornstarch and sugarcane. A PLA bottle left in the ocean would degrade in 6 to 24 months (Rogers 2015). One can also make PLA products using the same technology that manufacture PET bottles, which lowers the start up costs (ibid). The fact that PLA can be made from a variety of locally grown sources rather than one monocrop would help maintain biodiversity (Rogers 2015).

To address the second question, ecological management can represent the intrinsic value of nature in embracing not just instrumental function but integrity of ecological systems. Indeed, ecological management has the potential to take a bolder look at the distinction between human needs and wants. The Dopper, KK or the Plant Bottle of Coca-Cola, if used and reused might be a good thing – but the drive to produce more risks taking out ‘ecology’ out of production management. Braungart and McDonough (2009: 153) highlight the fact that within “sustainable development” discourses social and ecological concerns are often secondary to economic ones. While eco-effectiveness requires that ecological projects are also ‘economically fecund’ (ibid: 150; 153), it also requires recognizing the value of nature beyond mere utility.

Conclusion

The case studies show that transformation toward sustainable economy requires ecological management and responsible innovation that enable ‘circularity’ and the systems thinking not just about concrete products or production processes. They are also about a more general subject of human industry’s place in a wider ecosystem needs to be considered. Despite this challenge, while truly sustainable production still has a long way to go in practice, C2C and CE do, as least theoretically, demonstrate robust potential for positive change.

Yet caution is needed. Responsible innovation leaders and ecological managers have to consider trade-off involved in the use of “new” synthetic and biological materials, hopefully without reducing valuable elements of nature to mere resources for human use. The potential as well as limitation of the techno-cycle are well-illustrated by the case of KK and the fact that due to the longevity of the currently used steel products there is an inadequate amount of steel scrap in reusable streams. While presently KK is not in a ‘closed loop’ cycle, it would have the greatest potential to enter such a cycle if recycled steel were readily available.

One of the challenges is that drinking bottles' manufacturers are free to market their products as green without necessary controls from governments or consumers. As Frosch and Gallopoulos (1989: 152) have stressed, in order to be affective, the concept of circularity must be recognized and valued by public officials, industry leaders and the media in order to be instilled into the social ethos and adopted by government as well as industry. Ecological managers thus need to coordinate this effort in order to inform not just internal production processes but wider society to prevent regression to business-as-usual.

What is significant about Cradle to Cradle and circular economy frameworks is that despite impossibility of absolute decoupling of economy from consumption of natural resources, these frameworks go much further in their critique of current 'weak' models of sustainability based on eco-efficiency and recycling. While these frameworks can be greatly strengthened by explicit realization that economic growth and population growth make even relative decoupling more difficult, the focus on circularity offers an appropriate lens through which many sustainability initiatives can be assessed.

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