Towards ecological management: Identifying barriers and opportunities in the transition from linear to a circular economy

Abstract

This article will discuss philosophical debates on economic growth and environmental sustainability, the role of management responsibility, and the risk of subversion to business as usual. This discussion will be framed using the concepts of Cradle to Cradle (C2C) and Circular Economy about sustainable production. The case study illustrating the danger of subversion of these progressive models discussed here is based on the assignments submitted by Masters students as part of a course related to sustainable production and consumption at Leiden University. The evaluation of the supposedly best practice cases placed on the website of the Ellen MacArthur Foundation or those awarded Cradle to Cradle certificate has led some students to conclude that these cases illustrated green-washing. Larger implications of identified cases of green-washing for the field of sustainable 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 and consumption necessitated by resource scarcity is the cradle-to-cradle (C2C) framework, based on the book *Cradle to Cradle: Remaking the Way We Make Things* by McDonough and Braungart (2002). This book is inspired by the fields of industrial ecology (Frosch and Gallopoulos 1989), environmental or ecological economics and ecological management that stimulates growth and learning from nature, instead of using it as a resource to be consumed and depleted (Daly and Farley 2004).

C2C seeks to create essentially positive industrial systems, 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) will be beneficial to the environment. This consideration fits within the larger discussion of responsible innovation and ecological management, which 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; Block 2018).

There are several fundamental problems with the typical cradle-to-grave production system and associated management styles. As the current system of 'cradle to grave' production supports management practices that focus on economic benefits – thus manufacturing cheap consumer goods that are made *not* to last – the concept known as planned obsolescence (Bulow 1986). Managing sustainable business came to signify a marginal reduction in harm, rather than the complete elimination of resource-depleting production. ‘Waste to energy’ electricity, for example, which is touted as sustainable, makes valuable mixed materials 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 very effective in the long run as biomass is being slowly destroyed. Since producers are interested in consumers constantly buying their products, built-in obsolescence makes it economically unattractive to repair or reuse products. Also, many products are made with the ideas of ‘one size fits all’ (e.g. cement buildings that one can find anywhere in the world, despite local climatic conditions or materials), ‘brute force’ (e.g. toxic materials e.g. agricultural insecticides and herbicides), ‘culture of monoculture’ (e.g. palm or soya plantations) and ‘monstrous hybrids’ (packaging – for example, an average milk can contain 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 afterward (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 climatic differences, materials, and local knowledge. C2C encourages food production based on local properties of the soil and climate (McDonough and Braungart 2002) – thus ecological manager needs to have knowledge of or advisory team cognizant 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 the natural environment. Biodegradable packaging, for example, can be made to contain seeds, and when discarded, support biodiversity. Any waste can be seen as food.

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 the 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’ with products that should not be there in the first place (e.g. fossil fuels) (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 downcycling) but *infinitely reused*. Ideally, products that can be infinitely re-used can be an example of an 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 only facilitate, or indeed 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 but do not eliminate the need for virgin materials (Rammelt and Crisp 2004). Worse, in the context of a growing population and increased material demand, absolute decoupling appears to be wishful thinking that allows business-as-usual to continue (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, without discussing the paradox of trying to reconcile the increased need to produce, consume, and fairly distribute natural resources on the one hand and the need to preserve the environment on the other hand, ecological management needs to be careful not to present absolute decoupling as 'have your cake and eat it too' solution. Thus, ecological management needs to also confront the basic mechanisms of capitalist accumulation and ravenous industrial development system that requires a continuous supply of resources.

Thus, C2C is critical of the current emphasis on eco-efficiency as it emphasizes only partial or relative decoupling and fails to reimagine the destructive practices of the industry and merely allows them 'to take place in smaller increments over a longer period' (Braungart and McDonough 51; 54). Eco-Efficiency makes a destructive system appear 'less bad', yet essentially allows the industry to 'finish off everything, quietly, persistently, and completely' (Braungart and McDonough 2009: 62; 65). Ecological managers need to reach out to 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 1984).

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 reuses). 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. 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 achievable – or rather 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 and instrumentalism about natural systems will be addressed.

Origins of the Circular Economy (CE)

CE originates from the conception of the earth as a closed system with limited assimilative capacity and the inference that the economy and the environment should coexist in equilibrium (Boulding 1966) - the concept that came to be known as ‘self-replenishing economy’ (Stahel and Reday-Mulvey 1981) and later 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 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 the 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 lifeextension services such as monitoring and repair should lead to an increase in job creation. Murray et al. (2017:371) defined CE is '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'. Thus, CE is seen as a way to both minimize the waste-flow into the environment, and limit and ideally keep constant the number 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 the 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 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 resources (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 consumers. Transition to C2C and/or CE requires nothing less but profound institutional and cultural changes as well as shared understanding and transparency between all actors – governments, corporations, and consumers (Kopnina and Blewitt 2018). Optimistically, perceived risks of 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, like much else in the field of marketing, the noble aims can be subverted to the only former benefit – lucrative opportunities, forgetting sustainability.

The risks of subversion to business-as-usual

Ideally, the transition to a circular economy requires nothing less than radically re-designing industrial systems. Yet, the companies that are categorized as the 'best case studies' of the Ellen MacArthur Foundation seem to engage in conventional sustainability (Kopnina 2017, 2018). These case studies, including large iconic companies, often focus not on *elimination of* damage, *re-use*, and circularity but on *minimizing* damage, *recycling*, and eco-efficiency.

While biological cycles include the 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 the formation of new soil, production strategies that utilize ecological cycles can be called truly green (Kopnina and Blewitt 2018).

However, 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 2004). 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, the 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 here includes leadership in the transition to service economy but also in the focus on not just producing new products, but make does with what we have.

Economic motivation in adopting a 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 growth, and low carbon development strategy to stimulate continuous economic growth (Geng et al 2013; Ghisellini et al 2016). The films Beijing Besieged by Waste and Under the Dome illustrate the fact that circular economy is nowhere near its realization.

Without a strict certification system as with C2C, some companies that position themselves as “best practice” seem only grab the ‘low hanging fruit’ – investment in effortless or marginal changes rather than fundamentally rebuilding their business model. While the greater efforts might be underway, the largest parts of the companies operations remain ‘linear’ (Kopnina and Blewitt 2018). Also, while responsible innovation and ecological management have huge transformative potential, the words ‘management’ and ‘innovation’ risk to emphasize their 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).

Another danger is the rebound effect. Believing that technical fix can solve problems from energy to transport (e.g. there are many ideas about global geoengineering to reverse climate change) may subvert sustainability aims to the celebration of human ingenuity in changing the climate or even moving entire species. An example of this subversion is the Economist’s article states:

> “Paying for yet more wind turbines and solar panels is less wise than paying for research into the technologies that will replace them. Mankind will also have to think much more

> boldly... It will have to adapt, in part by growing crops that can tolerate heat and extreme weather, in part by abandoning the worst-affected places. Animals and plants will need help, including transporting them across national and even continental boundaries. More research is required on deliberately engineering the Earth's atmosphere to cool the planet" (The Economist 2015:4).

This blind belief in human ingenuity can sometimes make a circular economy sound like a magic wand without the need for a radical reorientation towards sustainable lifestyles and curbing population growth.

The assignments below address the challenges of C2C or circular economy to drinking bottles. These assignments were submitted in October 2016.

Case studies

The Ellen MacArthur Foundation, founded in 2009 is a registered charity to popularize and globalizing CE's appeal. The Foundation develops courses that stimulate innovation and encourages corporations, educators, and policymakers to follow the 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/). Yet, if strict assessment criteria are applied, few Ellen MacArthur Foundation's case studies appear to be really "best practice". For example, Cradle-to-Cradle certification spans over five different categories (material health, material utilization, renewable energy and carbon management, water stewardship, and social fairness) and five different levels (Basic, Bronze, Silver, Gold, Platinum). Such assessments, as examined by students in the case study reported here, rarely can make it into the 'hall of fame' but indicate 'business-as-usual', slipping back into unsustainable patterns.

Drinking bottles

These case studies are based on the assignments submitted by Masters students as part of the Environment and Development course at Leiden University in The Netherlands. The author was involved in coordinating and teaching this course at a Master of Anthropology program. As part of this course, the lecturer has identified some learning outcomes including the development of knowledge, skills, attitudes, and values to address sustainable production and consumption. One of the subjects discussed in class was a critical evaluation of supposedly best practice case studies from the website of the Ellen MacArthur Foundation. The students were asked to write an essay on the subject of C2C and/or CE product, evaluating it as a "best practice" or green-washing.

One of the students discussed an example of Coca-Cola bottles that have been placed on the list of best case studies while clearly, its operations present a clear 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".

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. The Plant bottle is actually made of less than 30% plant material, with the rest being non-organic, and is thus a 'monstrous hybrid', a material that combines both technical and organic materials that cannot be easily separated, thereby rendering it unable to be recycled or reused be either system (McDonough and Braungart 2002).

As opposed to partly organic "Plant bottle", polyethylene terephthalate (PET) plastic bottles rely on non-renewable oil and gas. The disability of these bottles has led to plastic waste entering our oceans, waterways, and landfills, only 10% of which is recovered and recycled globally (Green 2015).

Overview of the Dopper

The Dopper Original is a certified "Bronze" C2C product. A product receives an achievement level in each category — Basic, Bronze, Silver, Gold, or Platinum — with the lowest achievement level representing the product's overall mark (Cradle to Cradle Certified 2014). The colored Dopper 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 bisphenol A (BPA), an industrial chemical shown to interact with the body's endocrine system (Preserve 2016a). It also endeavors to reduce plastic waste (Dopper 2015d). Dopper states that by 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). Furthermore, the thermoplastics from which it is made are 100% recyclable. However, the company does not specify what percentage of the bottles is made from recycled PP or old Doppers. Although Dopper says that it is "produced with responsible water and energy use" it only received a Bronze for "Water Stewardship"(Cradle to Cradle Certified 2014).

While Dopper may be raising awareness about the impact of single-use plastic, the company is not highlighting the essential links between western overconsumption (in general) and environmental degradation. There is a quote from a customer on the Dopper website which 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 within sustainability discourses and does not address issues of corporate and political regulation that could potentially ban the sale of PET bottles entirely (Isenhour 2010).

Overview of the Klean Kanteen (KK)

The Klein Kanteen (KK) is a BPA-free water bottle made from 18/8 (18% chromium and 8% nickel) stainless steel, while the cap is made from silicone and bamboo. The bottle has a lifetime guarantee due to steel's lasting durability. Although KK states: 'a sustainable business is one that gives more than it takes' (Klean Kanteen 2016c), and despite stainless steel is 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 ore chromite is mined in South-Africa, Kazakhstan, Russia, and India (Materials World 2015). In India, chromite miners develop 'gastrointestinal bleeding, tuberculosis and asthma' as well as 'infertility, birth defects and stillbirths' as a result of overexposure to 'contaminated dust and water' (Das and Singh 2011).

Overview of the Polyethylene Terephthalate (PET) Bottle

PET is a synthetic plastic from the polyester family. Like the Dopper and KK, the production of PET bottles relies on oil and gas, but the fact they are designed for single usage makes them a particularly wasteful drain on the Earth's resources. There are thought to be 50 billion single-use PET bottles produced annually (Ban the Bottle 2016). There is a concern that chemicals such as phthalates, and BPA leach into the water, particularly if the plastic is exposed to high temperatures (Cooper et al. 2011). PET bottles are what Braungart and McDonough (2009: 37) refers 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 oceans…', ultimately feeding the Great Pacific Garbage Patch.

Comparison of Materials

Material Input per Service Unit (MIPS) is a method of assessing the environmental impact throughout the life cycle of a product or service (Rithoff et al. 2002). Due to a lack of information about the manufacturing, distribution and recycling processes of the bottles, the student noted it was not possible to use MIPS to explore their full life cycles. However, it was useful for comparing the environmental impact of the different materials, as shown below in Table 1.

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
	GHG	3.37	3.75	7.12	2.83	3.50
kg/Bottle	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

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 does the same thing for the material for one bottle. Klean Kanteen has the greatest environmental impact as it uses 44.19kg 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. The final row compares the number 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 47% of a KK bottle. Therefore, when one only examines the materials, PET bottles have the lowest impact on the environment. 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 and Distribution

PET bottles are made from PET pellets and recycled PET flakes, however, the recycled content of most PET bottles does not exceed 10% as the polymer chains of reprocessed plastic are weaker making it lose its physical properties. The pellets and flakes are mixed and heated to 315 degrees Celsius, which requires a significant amount of energy and probably creates a lot of waste heat. The thick liquid plastic is injected into molds, creating 'preforms', which harden instantly and move to a "reheat stretch blower molder". They are reheated and stretched into a bottle shape using a rod and blown air. Cold water is then used to set the mold. One machine can make 10,000 bottles in an hour (How it's Made 2013). The sheer volume of production means that a lot of oil and water are used. Indeed, over 17 million barrels of oil are needed for the production of plastic bottles in the US alone (Green 2015). Around 22% of PET bottled water sold in the UK is sourced from abroad despite there being an abundant source of mineral water (Balch 2015). Brands such as Evian and Volvic have private train stations at their factories in Europe, which results in 69% of bottles entering the UK by train (ibid). This is seen as a less polluting delivery method compared to transporting bottles by truck.

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 counties and it is not specified whether these emissions are also offset (Dopper 2015a).

Klean Kanteen bottles are 'handcrafted' 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 the 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 need 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, 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 fiber', 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 fibers used for synthetic clothing merely delays the cradle-to-grave life cycle, as the clothing eventually ends up in landfill (ibid: 6). While C2C favors products that can be reused or upcycled in 'technical production', downcycling, whereby the product returns to the technical metabolism 'at a lower level', is still preferable to products ending up on landfill (ibid: 171).

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 manufactures PET bottles, which lowers the start-up costs (ibid). The fact that PLA can be made from a variety of sources rather than one monocrop would help maintain biodiversity (Rogers 2015). Locally produced PLA bottles could rely on locally grown crops, so the sugarcane grown in Southeast Asia and the corn that is native to South America would not need to be replaced by a foreign species, thus avoiding 'a one-size-fits-all' (Braungart and McDonough 2009: 141).

However, bioplastics require plant materials, which can compete with food production. Also, there is inadequate infrastructure for recycling bioplastics as they end up in landfills (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).

C2C attempts to rethink the industry and human activity can 'get bigger and better in a way that replenishes, restores, and nourishes the rest of the world' (ibid: 78). However, none of the available water bottles appear to do this. The move towards reusable water bottles has also had a very limited effect on the consumption of single-use bottled water (ibid: 93). In 2007 consumption of bottled water in the US stood at 8.8 billion gallons and in 2010 this figure was to 8.75 billion in

2010 (ibid: 94). She concludes: 'We are using water bottles in addition to, not instead of, bottled water', which suggests that "sustainable" companies such as Dopper and Klean Kanteen are failing in their aim to reduce the use of single-use water bottles (ibid).

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.

Higher taxes on PET bottles and increased regulation are required to cut consumption of single-use bottles; infrastructure must be expanded for systematizing the *reuse* of PET bottles over recycling, and infrastructure is needed for recycling bioplastics so they can biodegrade and reduce the need for oil and gas-based plastic bottles.

Reflection

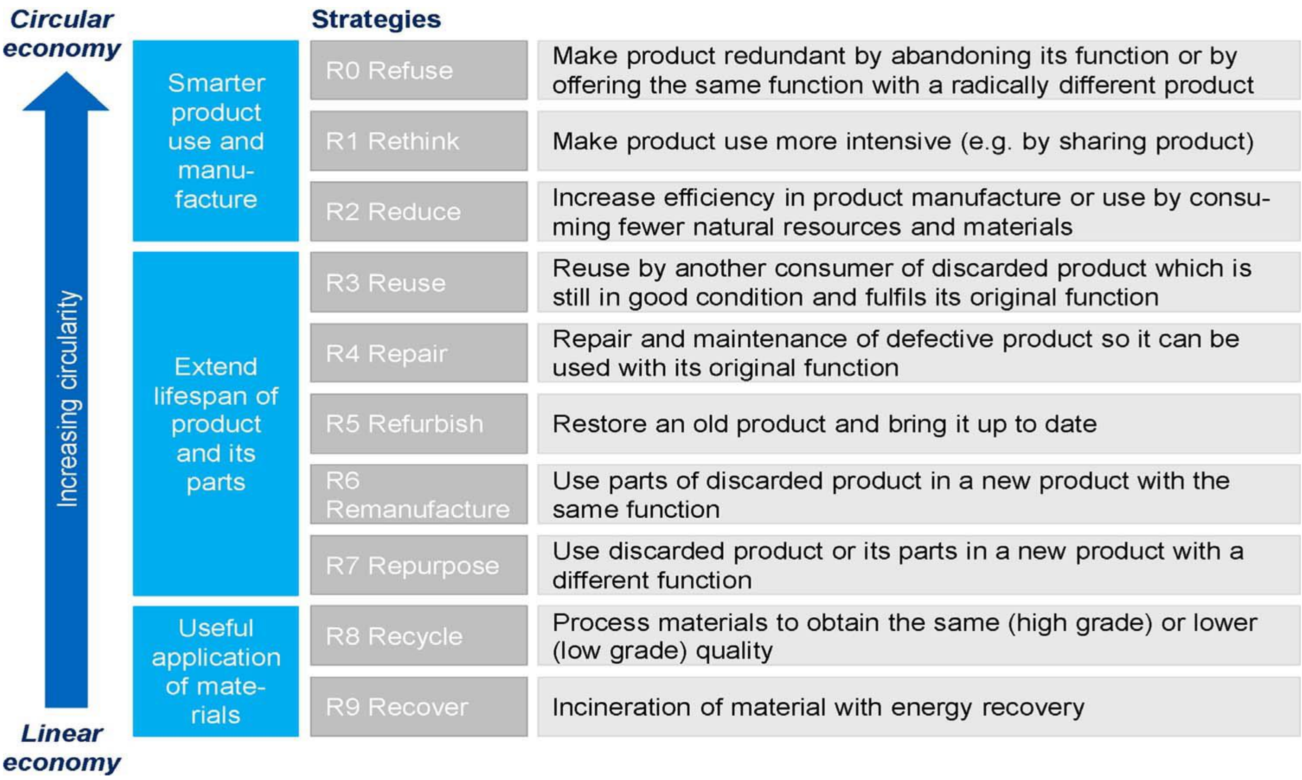
Analysis of the different water bottle options to the broader research questions about C2C and CE practices and their limitations and the subversion to business as usual. The potential future returns of saving materials for companies engaged in sustainable production might be possible, the cases of bottles 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 study 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 the C2C/CE transformation.

Yet, once again, caution is required. 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). While this optimistic outlook certainly bypasses consumers' attempts to "buy less" (Isenhour 2010: 460), it does not consider the fact that population growth and the spread of the "Western way of life" is not something that can be simply "innovated away" by new smart designs. 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 (2004), 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 the economy, Victor and Jackson (2015) note that while there has been some ‘relative’ or partial decoupling’, any absolute decoupling is not evident.

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, and in some cases, the products illustrate the 'bad' practices described by these frameworks (e.g. Plant Bottle is a "monstrous hybrid"). While it is possible to have one hundred percent CE or C2C products, it might be expansive or technically challenging. To use the same Plant Bottle as an example, 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 the production of new, virgin material bottles all the more problematic.

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 the environment. It remains challenging to achieve the maximum technologically and economically viable decoupling. 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). The overall reduction in production through continuous re-use of durable products made of non-toxic materials offers a better solution.

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



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 a 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, in reflecting on what is the role of organisational management and the logic of economic growth in the depletion of the natural resources is, ecological manager needs to take heed from the warnings that resources, however, produced, if consumed by a large number of people, can 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 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, while some designs are better then others, the production of neither Klean Kanteen nor Dopper, not Plant Bottle shows a shift toward a system that will be replenishing, not just to the producer's purse, but to a natural system from which natural resources for making these bottles are derived. 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 the restoration of the system. Despite the impossibility of absolute decoupling of resource use and economy, most promising are the products and services where 'circularity' can be reached to at least some degree. This objective can be realized by production to service shift (sharing and reusing 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, however, also requires honest understanding that the 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.

To address the second question, ecological management can represent the intrinsic value of nature if this management embraces not just instrumental function but the 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, The Klean Kanteen or the Plant Bottle of Coca-Cola, if used and reused once and forever 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 a sustainable economy requires ecological management and responsible innovation that enables 'circularity' and the systems thinking not just about concrete products or production processes but 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 processes still have a long way to go in practice, C2C and CE do, at least theoretically, demonstrate the robust potential for positive change. Good examples can be found in 'pre-industrial' designs, as demonstrated by the milkmen distributing refillable and washable milk bottles, or clay pots as containers.

Yet here again caution is needed. As one of the students reflected in the case of Plant Bottles, if plant-based materials such as corn and sugarcane became the sole source of bioplastic, the amount of land and water required for their cultivation would be a threat to global food security. Thus, responsible innovation leaders and ecological managers have to consider trade-off involved in the use of “new” synthetic (techno-cycle) and biological materials, hopefully without reducing valuable elements of nature to mere resources for human use. The potential, as well as limitations of the techno-cycle, are well-illustrated by the case of Klean Kanteen 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, to be effective, the concept of circularity must be recognized and valued by public officials, industry leaders and the media to be instilled into the social ethos and adopted by the government as well as industry. Ecological managers thus need to coordinate this effort to inform not just internal production processes but wider society to prevent regression to business-as-usual.

Instead of making new products, re-use can also offer a simple and cheap way of cycling resources. 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 (that often make the bad system last longer) and recycling (which is in fact down-cycling). While these frameworks can be greatly strengthened by explicit realization that economic growth and population growth are going to make a challenge of even relative decoupling more difficult - as the total number of mouths to feed grows - the focus on circularity seems to be an appropriate lens through which many sustainability initiatives can be judged (and in most cases criticized as very few things are presently 'decoupled'). While C2C and CE do not necessarily have to support pre-industrial design, smart and honest innovation can also offer hope. C2C and CE manufacturing and management can be truly transformative when economic, political or social barriers are lifted and ideas about circularity with the aim of absolute decoupling are widely shared.

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