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**Abstract**

Increasingly, entrepreneurial growth is discussed in relation to business sustainability and the wider questions of 'growth' – economic, green, or sustainable. This chapter will discuss the challenges and opportunities of teaching circular economy and Cradle to Cradle (C2C) models of sustainable production. The course applying circular economy theory to corporate case studies at the liberal arts college in The Netherlands will be discussed. Students were given the assignment to advise an existing company how to make a transition from a linear to circular economy model.

**Keywords**: circular economy • cradle to cradle • sustainable business • sustainable consumption

## Introduction

### The concept of sustainability

Entrepreneurs are increasingly exposed to the topic of business sustainability through courses in business administration, management, and economy. It becomes increasingly difficult to speak of entrepreneurial growth without questioning 'growth', be it economic, green, or sustainable growth. Sustainability education typically involves competencies that enable students to develop their knowledge of sustainable production strategies as well as consequences of their own consumption choices (Andersson and Öhman 2016). The mainstream sustainability models tend to focus on eco-efficiency and minimizing environmental damage, failing to address the deeper underlying causes. In these eco-efficiency models, the damage to the environment due to intensifying production and consumption is minimized or delayed in time, but not eliminated and negative effects are delayed (McDonough and Braungart 2002).

Critical scholars have pointed out that it is questionable whether the triple objective of balancing social, economic and environmental objectives is feasible since human equality and prosperity can hardly be achieved with the present rate of population growth and natural degradation (Rees 2009). As John Huckle and Arjen Wals (2015) have noted, in order to address sustainability challenges, we need to teach our students to link unsustainable consumption to the structures and processes that shape consumer capitalism. In fact, the stated goal of maintaining economic growth, re-distributing of wealth while simultaneously securing environmental integrity may be impossible (Rees 2010). John Foster (2012) has

noted that the current modules of sustainability have largely failed, and the sense of optimism that is shared by many proponents of sustainable development gives little more than false hope (Kopnina 2012).

One of the key problems of environmental unsustainability in production is waste (Girling 2011). The rebound effect refers to the fact that technological improvements and efficiencies actually stimulate more consumption by absolving consumers of their guilt (Greening, Greene and Difiglio 2000; Kopnina 2014). The consumption of "green" products, rather than absolute reduction in consumption is well-illustrated in the case of energy efficiency, as efficiency gains are reallocated to increased consumption (Isenhour 2015). Most of the so-called sustainable or eco-efficient products are still produced in a linear system in which products are made of raw materials, used, and discarded (McDonough and Braungart 2002).

An alternative to conventional sustainability includes Cradle to Cradle (C2C) (McDonough and Braungart 2002) and the circular economy (Webster 2007) models. The three key design principles of C2C are waste equals food, the use of current solar income, and the celebration of diversity. The first principle explains that just like how organic waste becomes 'food' for other organisms, benefitting various elements of the ecosystem. The second principle is the use of "current solar income", or the use of relatively endless (in "human years") renewables, such as solar energy. Celebration of diversity refers to recognition of the healthy ecosystem, which is interdependent and complex, unlike currently used agricultural monocultures.

The circular approaches are basically critical of conventional approaches to sustainability which seek to reduce rather than eliminate damage. Even the well-intentioned practices such as recycling, lead to mostly downcycling, where materials are reused to make products of lower quality, which require energy to be actually given new (and lesser) life. As the authors of the C2C principle reflected, a bad thing should not be efficient (McDonough and Braungart 2002). Eco-efficiency, as in the case of "saving electricity" the authors argue, will only prolong the essentially unsustainable system, in which electricity, for electric cars for example, still comes from fossil fuels (Ibid). Rather than downcycling (converting valuable products into low-value raw materials), upcycling (converting low-value materials into high-value products) was proposed. Yet, research in sustainability education is usually limited to studies that discuss the conventional models of sustainability, which focus on efficiency, rather than these transformative models (Kopnina 2013).

This chapter will focus on transformative models of sustainability and its implications for entrepreneurial growth. The sections below will examine production models that reach beyond conventional sustainability with its focus on closed-loop models and then turn to examples from educational practice. The reflection will explore how students can be taught to distinguish between linear and circular models and how the pitfalls of subversion can be avoided. The implications for teaching

circular economy to bachelor's students will be discussed within the case study of an experimental online course at the Leiden University College in The Netherlands. This course was targeted at increasing students' awareness of alternatives to mainstream production models.

**Transformative frameworks**

William McDonough and Michael Braungart (2002) have argued that a new post-industrial revolution is needed to reverse the unintended negative effects of industrialization. This revolution should ideally develop the types of products that stay in the "loop" – without materials that need to be thrown away. C2C framework (McDonough and Braungart 2002) proposes a radical production revision that equates waste to food, and thus eliminates any 'unproductive' waste. A good illustration of this principle is the idea of generating biofuel for energy consumption from waste. While at present most waste ends up in landslides or incinerators, most of it is simply wasted. Burning garbage to generate energy may seem 'green', but it is only one step removed from the cradle–to- grave model in which valuable materials are lost (McDonough and Braungart 2002). In reality, "Waste to Energy" contributes to environmental degradation, literally wasting valuable resources by exacerbating raw material shortages and intensifying the loss of CO2-capturing topsoil. It also prevents effective recycling due to competition for high-caloric recyclable content:

> *The "Waste to Energy" paradigm fails to consider the high nutrient value of waste or the hazardous impacts of burning them for cheap fuel. Through incineration, we are throwing away exhaustible raw materials, along with the energy needed to mine natural resources and manufacture them into consumable products. With this approach, not only do we lose valuable nutrients, but we also create an aggressive disincentive for materials' reuse*.[1]

In a similar way, the circular economy is promoted as a way of retaining valuable nutrients and infinite reuse of materials. Ellen MacArthur Foundation that promotes circular economy encourages re-thinking of business models in relation to product design as well as forward and reverse supply chains in order to reach and maintain operational efficiency (Lieder and Rashid 2016). This means that the products need to be designed in such a way that the entire supply chain, from raw materials to waste, becomes "circular". This also requires an economically feasible value recovery as part of efficient closed-loop supply chains (Ibid). The circular economy model emphasizes the role of diversity as a characteristic of resilient and productive systems (Brennan, Tennant and Blomsma 2015). Translated into business practice, this involves the private sector in seizing business opportunities within manufacturing based on a system of product loops consisting of reuse and repair activities (Lieder and Rashid 2016).

[1] Braungart 2013.

This business practice needs to follow a number of principles outlined in C2C. The “waste=food” principle is well illustrated by the metaphor of the cherry tree, which produces ”waste” (berries, leaves, etc.) that actually serves as food for other species and for the formation of the soil (McDonough and Braungart 2002). C2C proposes that only biodegradable materials, such as organic materials and non-compostable materials that can be infinitely re-used should be used. This way, a product can be disassembled and the two kinds of materials can be either used for fertilization or for ‘within-the-loop’ manufacturing processes that do not require virgin materials. Inspired by such frameworks, some companies have noted that closed loops model corresponds with business sense through its potentially immense savings. Yet, making a true C2C product is not easy. C2C certification involves five categories, namely material health, material reutilization, renewable energy, water stewardship, and social fairness. Depending on how a product performed in each of these categories, a certificate of basic, bronze, silver, gold, or platinum is awarded.

**The Risks of Subversion**

One of the weaknesses of the circular systems is that a product is in use for longer periods of time – potentially indefinitely as it can be infinitely reused or refitted. This rejects the built-in obsolescence principles that many companies employ to prompt consumers to keep on buying new products (Kopnina and Blewitt 2014). This implies that direct sales of new products decrease, impacting on-going profits that could otherwise be made (Brennan, Tennant and Blomsma 2015). The key to solving this conundrum is of the steady state economy with a fixed population and a constant sustainable throughput of resources. As the case study below will illustrate, circular economy and C2C can also be co-opted to justify business as usual models, both practically, and in educational practice.

The circular economy models are not without limitations as they can be used to justify further "business-as-usual" growth (Washington 2015). The ‘pioneers' of the circular economy or C2C have indeed sometimes profited from setting up certification systems, limiting the global applicability of their concepts, or sometimes cooperating with companies are far from strictly adhering to these frameworks (Brennan, Tennant and Blomsma 2015).

**Case studies at Leiden University College**

The author was also involved in the instruction of students of the advanced course Environment and Development (E&D), the elective advanced course at Leiden University College (LUC). The course was given in 2016. Twenty-one students participated in E&D. One of the objectives of the course was to

encourage students to examine existing models and develop suggestions for C2C or circular economy products based on different frameworks of sustainability (for a detailed description of the course see Kopnina 2017).

One of the students has summarized the principles of C2C in his essay as "using an analogy of nature". For instance, the student stated,

> "an apple tree produces apples and when the season is finished, the fruits that were not picked, fall to the ground. Instead of becoming rubbish, they decompose and nourish the soil for the tree and other plants to grow. This cycle can be repeated again and again without leaving behind any waste.[2] The C2C framework utilizes this very normal and obvious part of nature".

Applying this framework to the product Method, a company that produces environmentally friendly home cleaning products, and has a gold C2C certification, the student has written:

> "Applying this framework, are the five different categories a product has to satisfy in order to be C2C approved. Method has been awarded gold with their products. We will explore how their products perform in each of these categories to be awarded gold. The first category of assessment is material health. It looks into whether the chemicals in products during their intended and unintended use and end-of-use phases are hazardous. Not only this, but it also considers chemicals that were used to produce certain inputs.[3] In order to achieve platinum, the highest possible level of certification, a product cannot contain materials or chemicals that do not have enough data on their toxicological information and highly problematic in terms of C2C perspective. On Method's website, all the ingredients used for production are listed. While most of their ingredients are biodegradable, some contain toxins that might cause skin or eye irritation.[4] Method lists all the chemicals that are *not* used because of their harmful effects on health and the environment. In addition, they proudly state that they do not use ingredients that are not safe for humans and the environment.[5] Some ingredients that are not fully biodegradable, and may cause skin and eye irritation. The company works with its suppliers to replace petroleum-based ingredients with bio-based ones. Looking at all these achievements, it seems like their products deserve gold in the material health category.
> The second category is material reutilization. The basic framework of C2C states that waste has to equal food, indicating that a waste of a product should be beneficial for the ecosystem and the environment. This category measures if products can be perpetually cycled.[6] The majority of Method's products are made out of 100% Post-Consumer Resin (PCR) plastic. Compared to virgin plastic, PCR plastic has a 70% lower carbon footprint. In addition, Method uses polyester terephthalate (PET) and high-density polyethylene (HDPE) for most of their products. These plastics can be widely recycled. The company avoids using polyvinyl chloride (PVC) and polystyrene because of its lack of recyclability. Their packaging design also accounts factors like recyclability, packing weight, reusability, and compostability. In order to reduce the amount of plastic used, they provide refill pouches for their products such as hand wash, laundry detergent,

[2] Kopnina and Blewitt, "Sustainable Business".
[3] "Cradle to Cradle CertifiedCM Product Standard".
[4] "Method – People against Dirty".
[5] Ibid.
[6] "Cradle to Cradle CertifiedCM Product Standard".

and dish soap. Refill pouches account for 80% less water, energy, and plastic. In order to combat the issue of ocean plastic, Method launched the world's first plastic bottles that were made from ocean plastic.[7] All these attempts satisfy the second category, material reutilization. Not only do they produce bottles that can be widely recycled, thus, forming a perpetual cycle, they also produce their bottles from using plastic that has become a waste. This process benefits the ecosystem and the environment.

In order to mirror the natural metabolism, the C2C assessment measures if renewable energy has been used for production. In order to achieve gold in the assessment, 50% of the company's purchased electricity has to come from renewables.[8] To meet this category, Method internalized their carbon reduction strategy. The goal of this internalization is to minimize their carbon emission and facilitate energy conservation. To meet this goal, Method has purchased renewable energy credits and their buildings are Leadership in Energy and Environmental Design (LEED) certified. LEED certification considers factors such as materials, smart grid, water efficiency, and performance-based. This is further evidence that Method's buildings are sustainable. Furthermore, they also offer financial incentives to their employees to use public transportation from their home to the office and to their suppliers to enforce energy and water conservation strategies. On an interesting note, trucks that deliver Method's products run on biodiesel, a renewable substitute of petroleum diesel. They not only try to use renewable energy sources for the production of their goods but they also encourage their employees and suppliers to do the same.[9] This, therefore, is making a greater positive impact on the environment. They deserve gold for this category for sure.

The second last category of the C2C assessment is aimed towards protecting the most vital resource, water.[10] This category measures if the company treats water as a valuable resource and if effluents do not contain any chemicals that are problematic. Method performs pretty well in this category as well. In order to reduce the amount of water use and the level of contamination, the company uses several methods. For instance, one of the facilities of the company uses reverse osmosis water production. This gets rid of chemicals in the water intake. Moreover, to save water, one of their detergents does not include any added water.[11] However, this is just one of their products. In fact, one of the reviews says that Method does not have enough concentrated formulas but instead, most of them are pre-diluted, which uses more water. [12]Therefore, there is still some room for improvement. If one recalls, their products are biodegradable and environmentally friendly. This makes sure that even if they are dumped into nature, they will not contaminate water bodies. Although one of the reviewers pointed out an area that Method can rectify to work on their water stewardship, most parts of it look like they are in the right direction.

The last category of the C2C assessment is social fairness. Social fairness measures if the business contributes to the interests of all employees, customers, community members, and the environment. It mostly accounts for business ethics such as fair treatment of workers and reinvesting in nature.[13] On the website, Method has a page dedicated to explaining their working space… They stress and highlight that they have fun. It looks an ideal place to work simply by judging from what appears on the website. Additionally, the company offers three days of volunteer work to its employees per year. According to their B Corp survey, workers are paid more than the living wage and they are health insured.[14] Also, as mentioned before while discussing renewable energy categories that their suppliers are paid to reduce carbon emissions.

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[7] "Method – People against Dirty".
[8] "Cradle to Cradle CertifiedCM Product Standard".
[9] "Method – People against Dirty".
[10] "Cradle to Cradle CertifiedCM Product Standard".
[11] "Method – People against Dirty".
[12] "Method Cleaning Products Reviews And Information".
[13] "Cradle to Cradle CertifiedCM Product Standard".
[14] "Method Products, PBC."

> Whether they reinvest in natural capital is nowhere to be found. However, when it comes to the fair treatment of the employees, the company seems to be doing an excellent job.
> The company excelled in every category of assessment. However, since the majority of the information about the company and its products has been taken from their website, some of the information could have been a little biased. For instance, they could have made their working space sound better than how they described. Most of the information regarding C2C assessment could be found on the website itself besides a few areas. The social fairness category also looks as if the company reinvests into natural capital. However, this information could not found on the website. Also, there was not enough information about water stewardship. From the information found, it seems like they are doing some work to reduce their consumption of water and to minimize water contamination. However, their exact information on what kind of technology they are investing in or using was not found.

Another team of students focused on "green fabric" of Climatex, patented by Rohner, a company that has incorporated the "waste = food" principle in fabric design, resulting in the fully biodegradable quality fabric which was awarded Gold-level C2C Certification (http://www.c2ccertified.org/innovation-stories/designtex). An extract from student assignment demonstrates how the company and material works:

> "Rohner Texil not only illustrates the C2C concept, but offers an outlook on the business ecosystem in such a process, and its limitations.[15] Environmental improvement is often seen as a cost for manufacturing industries, as opposed to a means for financial gain. However, Rohner successfully implemented environmental strategies while reducing fixed costs and promoting growth.[16] The process highlights how there are various stakeholders to consider when pursuing a C2C design… Out of 60 dye manufacturers, only 1 agreed to the inspection. Only 16 out of 8000 were deemed safe and appropriate. Furthermore, they were using wool from "free-range sheep and pesticide-free ramie", but there were added chemicals to the process. They got a new mill and were finally able to produce clean water out of their processing. All of these steps exemplify: 1) how strict C2C design is, 2) how *wrong* we have been manufacturing since industrialization. Rohner is a prime example that should be replicated into other business schemes. Firstly, there is much environmental regulation in Switzerland that simultaneously helped them achieve a fully sustainable system. In contrast, if Rohner was established in China, the procedure would have more milestones towards C2C".

(Figure 1 'Climatex' here –see Appendix).

Another student group made a presentation about Bakey's edible spoons and other utensils, made of water, sorghum flour, rice flour, and wheat flour, without preservatives and pesticides (http://www.bakeys.com/). The company was established in 2010 in Hyderabad, Andhra Pradesh, India, as an alternative to disposable plastic or wood cutlery and bamboo chopsticks. The cutlery was particularly intended for developing countries, such as India, as it has the greatest amounts of plastic waste and pollution because of the ready availability of cheap disposable plastic utensils. On the surface of it, the product appeared

[15] "Rohner Textiles: Cradle to Cradle® Innovation and Sustainability," C2C-Centre, April 01, 2007, accessed October 13, 2016, http://www.c2c-centre.com/library-item/rohner-textiles-cradle-cradle%C2%AE-innovation-and-sustainability.
[16] Ibid.

Cradle to Cradle as one can literally eat one's waste and one uses 'solar income' for plant matter. Celebrating diversity can be related to counteracting monoculture of rice, and the product design is both innovative and traditional (see Appendix 2).

The group has noted a few features that have made this product less C2C. Spoons were sold in plastic wraps. It was unclear where the energy used for production come from and how exactly does the factory in India function. The transport used for distributing the small orders of cutlery was also noted as problematic. The students noted that considering the low-end target market, edible spoons were two times more expensive than plastic spoons. While the company got funding from the crowdfunding platform Kickstarter, the funding from mostly American donors made the product too expensive for average Indian consumers, as well as too expensive to ship to America to compensate the donors. The students have thought of a number of solutions, including bigger capital that should come from investors in the target market, particularly the Indian wealthy and environmentally-aware consumers, and keeping all distribution in India to lower the cost and eliminate transportation problems. More transparency as to the way the factories are operated, and products delivered and packaged were found desirable. (Figure 2 'Edible spoons' here – see Appendix).

The MacArthur Foundation also lists a great number of business-related case studies, including projects by large brands. One of these case studies is Coca-Cola Enterprises' commitment to "maximizing the usage and value of the plastics used in bottle production" (EMF 2016a). The student reflected:

> "The goals of this Coca-Cola bottler include a reduction of the materials used in the bottling process, an increase in renewable content used and an increase in the overall recyclability of the packaging. The main strategy adopted to achieve these goals seems to be increased use of PET (polyethylene terephthalate) to produce bottles and subsequently recycling this plastic as 'rPET' to create new bottles (ibid.). In recent years, the company even trademarked the concept of the 'PlantBottle', which owes its name to the fact that its PET is *partially* based on plants (up to a maximum 30%) (Coca-Cola 2015).[17]
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> The primary materials for PET are originally derived from crude oil (PlasticsEurope 2010). With its 'plant-based plastics' the Coca-Cola company managed to make that 30% of their plastic bottles are derived from bioethanol from Brazilian sugarcane (Coca-Cola 2015). Coca-Cola's competitor Pepsi even went a step further by being the first to create a bottle of which both PET compounds (ethylene and terephthalate) were created from biomass (F-T.com 2011). Because the use of oil is significantly reduced by these initiatives, they do reduce the carbon emissions associated with bottle production (ibid.). Coca-Cola claims that the introduction of its plant-bottle packaging has reduced carbon dioxide emissions by 270.000 metric tons since its introduction (Coca-Cola 2015).
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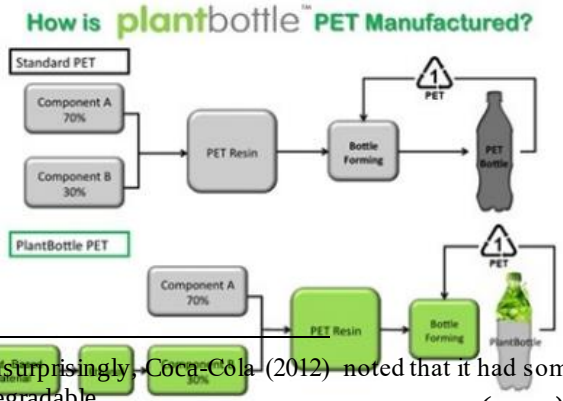
> Nevertheless, the plant-based plastic is chemically still identical to the oil-based PET (Terry 2011).




*Source: Coca-Cola (2015)*

[17] Unsurprisingly, Coca-Cola (2012) noted that it had some difficulties communicating that its 'PlantBottles' are not biodegradable.

> This means that the plastics have the same problematic properties as their oil-based predecessors: they are not biodegradable (Coca-Cola 2015) and could contain toxic substances that can harm wildlife (Terry 2011). Because the bottles are 100% recyclable the companies argue that these properties are in itself not a problem. However, the bottles that are recycled require an extensive transporting network and a potentially unsustainable production chain. Next, to that, 25% of the bottles still end up not being recycled (Coca-Cola 2015)[18], and therefore might become part of the ever-growing 'plastic soup'. Finally, even though using sugarcane instead of oil is a step forward, the effects of pesticide, herbicide and fertilizer use in Brazilian sugarcane production on local water resources are still unknown (Filoso et al. 2015). The wider monitoring of the sustainability of biomass also remains a challenge that has to be faced (Pavanan et al. 2013).

In response to the problems associated with the current use of plastic packaging worldwide, the Ellen MacArthur Foundation (2016b) published the report "The New Plastics Economy" at the 2016 World Economic Forum in Davos. As a result of this report, the 'New Plastics Economy' initiative was launched to "build momentum towards a plastics system that works" (NPE 2016). The companies, policymakers, academics, and NGOs engaged in the project - again also including Coca-Cola - try to rethink the current plastics economy (ibid.). Finding real sustainable alternatives to plastic packaging proves to be very challenging. The UN Environmental Program's chief scientists described many of the current biodegradable plastics as "well-intentioned, but wrong" (Vaughan 2016) because they only break down under certain conditions, which are unlikely to be found in, for instance, the sea.

The benefit of aluminum cans as compared to PET bottles is that aluminum can be recycled without quality loss, while PET-recycling in practice means 'downcycling' (Gunther 2015). The company Novelis, therefore, produced the 'evercan': a beverage-can that consists of a minimum of 90% recycled aluminum (Novelis 2016). With the 'evercan', Novelis claims to have achieved a 95% reduction in energy use for its beverage-can production (ibid.). Yet, again, there are various problems associated with the supply chain and life cycle of aluminum cans when it comes to the circular economy model. First of all, the raw material for aluminum, bauxite, is acquired through open-pit mining, for which large areas of forest are destroyed. Secondly, the production process of aluminum leaves residues that can be harmful to the environment (Power, Gräfe and Klauber 2011). On top of that, not all aluminum is recycled. As a result, some cans end up in nature where they biodegrade very slowly. A student wrote:

> Alternatives that might be more in line with the circular economy model could be found in home-compostable packaging and edible packaging. For example, NatureFlex packaging films are made from wood-pulp from managed plantations that work in line the 'Forest Stewardship Council' certification and the 'Programme for the Endorsement of Forest Certification' (Innovia 2016). The films can be composted, and some types of NatureFlex films have proven to biodegrade in waste-water (Futamura). Even more interesting is the US Department of Agriculture (USDA) development of an edible film made of milk protein (Boztas 2016). In the future, the film could potentially be used for oxygen-free packaging of a wide variety of products. Nevertheless, for

[18] Because these data are based on Coca-Cola internal figures their validity cannot be checked.

both of these products, it is at this point hard to determine how sustainable the production processes really are.

One of the first examples of supposedly best practice cases on MacArthur's website (https://www.ellenmacarthurfoundation.org/ce100/directory/the-coca-cola-company) is Coca-Cola's "circular system" for PET-bottle recycling. As students have noted, the high percentage of downcycled PET bottles is not even collected, making this initiative a case of 'greenwashing' (Zara 2013). Such 'best examples' typically change a small part of their operation or product, such as an amount of plastic used for making a plastic cap for a one-time-use plastic bottle. Reflecting on limitations of practical applications of circularity models, a student wrote:

> "Pre-industrial approaches or innovative ideas will require a lot of investment, especially if they completely overhaul current practices. It is very questionable whether multinational companies like Coca-Cola that have operated in a growth- and profit-oriented system for decades will be able to voluntarily abandon low-cost plastics for more costly sustainable alternatives. Yet, if consumer preference continues changing towards more sustainable alternatives, such companies are ultimately also bound to change their ways. Most governments are also held accountable by their population and will increasingly be pushed to set proper regulatory frameworks, support transformative projects and finance innovative research. A critical mass of progressive thinkers in branches of government, business and society could significantly stimulate this change and mobilize the necessary public support".

To sum up, a closed-loop system for production, distribution, and consumption could significantly reduce resource extraction and waste. Yet, the examples of the Ellen MacArthur Foundation still fall short of circularity.

Examples of more "honest" circular products are not hard to find, as they were present in all pre-industrial production systems, from buildings made of local materials to biodegradable textiles and clay cooking pots (Kopnina and Blewitt 2014). Experience with commercial companies shows that with smart marketing one can sell old ideas as new, and while the circular economy can have many different applications, the basic principles remain within reach of existing or past technologies (Winans et al 2017). This does not mean that producers and consumers should revert back to a pre-industrial lifestyle, or that producer will be selling "back-to-the-cave" products. Innovative strategies involve the use of transport that ranges from wind-energy powered public transport to solar airplanes, such as Solar Impulse has recently completed its journey around the world (Abbe and Smith 2016).

It can be also argued that it is time to go back to the circular systems our ancestors understood. But even with 'old' technologies or distribution principles, such as refillable bottles distributed by a milkman, traditional forms of the circular economy can be easily found. From the point of view of the circular economy, such "blessings" of the industrial revolution as "cradle to grave" production is a historical misstep made during the industrial revolution. More optimistically, what is a few hundred years

in the course of millennia of the human history of production and innovation? Thus, the wide application of a circular system of production is highly warranted.

## Conclusion

When noting potential pitfalls in both practice and teaching of the circular economy, it is important not to throw a baby out with the bathwater. When considering C2C and circular economy, it is important to distinguish between what is feasible and realistic and what is ideal. One way of approaching the challenges of the transition to a circular economy needs to be developed by, for example, embracing economic and social pragmatism and partially abandoning ideal or theoretical objectives of closed loop systems. This requires an emphasis on a critical examination of the entire supply chain. This is helpful in evaluating the overall "sustainability value" of courses such as those presented above, as well as being able to judge some ideas for sustainable production and consumption as better than others. This has implications for entrepreneurial growth in both production and service sectors. One needs to distinguish between desirable and less desirable types of growth – one that is about the growth in benevolent, transformative, circular models, and growth in strictly economic terms. The latter type may endanger any long term entrepreneurial growth simply put because the current method of production cannot be decoupled from unsustainable consumption of natural resources and production of waste. Progressive entrepreneurial growth is highly dependent on the circular model as a radical alternative to the business-as-usual scenarios that only stimulate short-term profit-seeking.

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## Appendix

Figure 1. Climatex

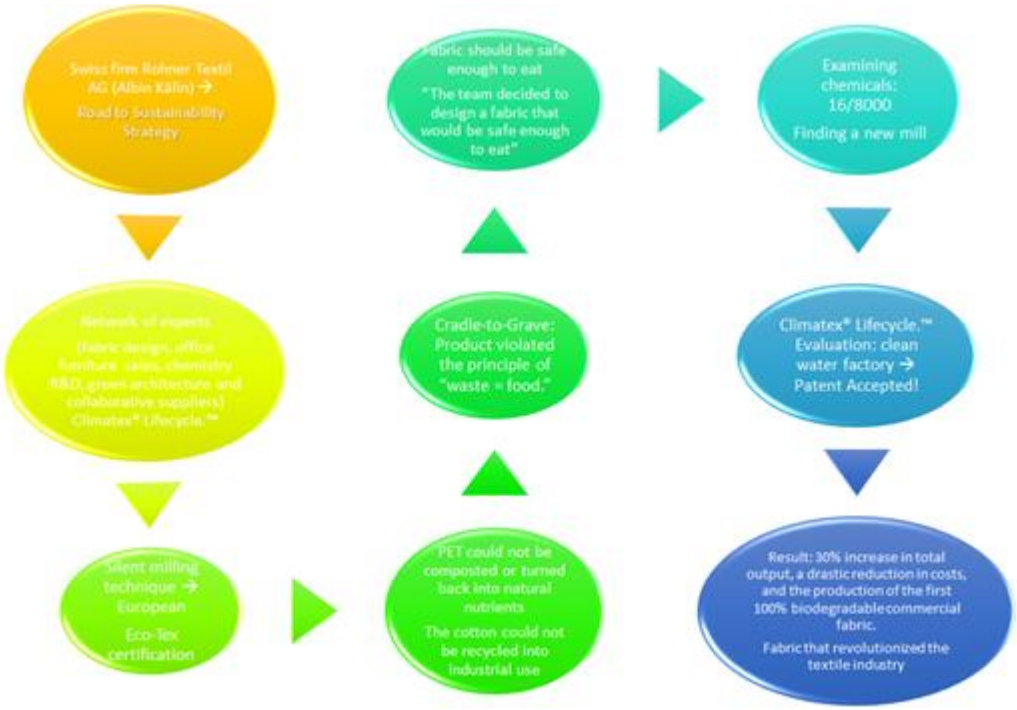
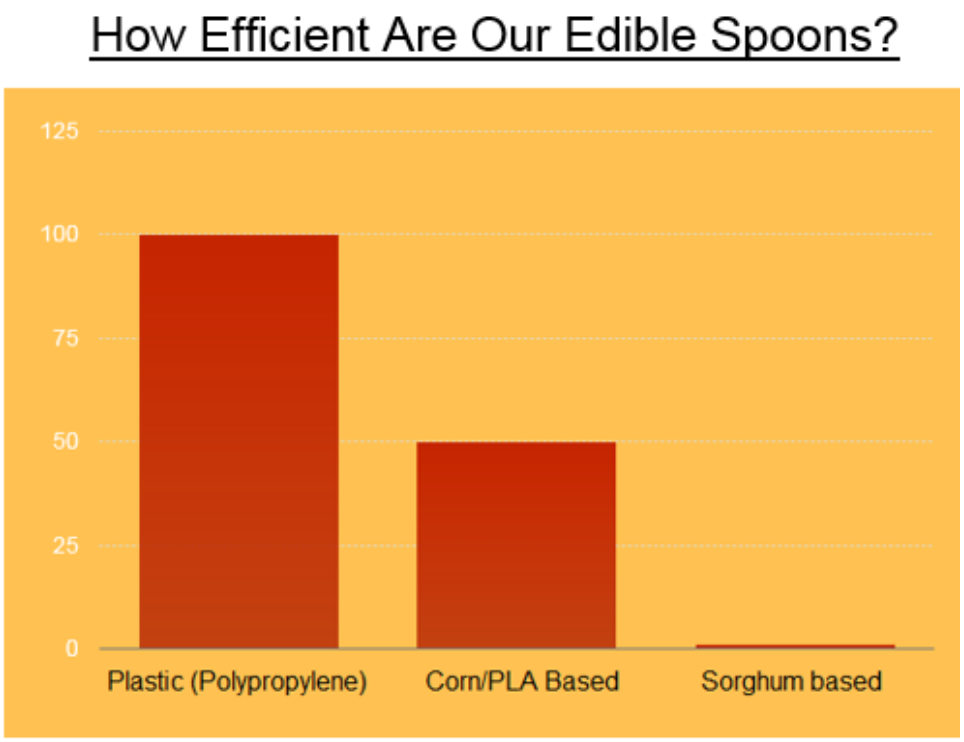



Figure 2. Edible spoons




| Manufacturing One Pound of the Material | Energy Used (kWh) | Water Used (gals) | Solid Waste (lbs) | $CO_2$ Emissions (lbs) |
|---|---|---|---|---|
| PP (Polypropylene) | 9.34 | 5.12 | 0.029 | 1.67 |
| Corn PLA | 5.37 | 8.29 | 0.042 | 1.30 |
| Sorghum | 0.18 | 1.15 | n/a | 0.19 |

**Author's biography:** Dr. Kopnina, Helen (Ph.D. Cambridge University, 2002) is currently employed at both at the Leiden University and at The Hague University of Applied Sciences (HHS) in The Netherlands. At the Leiden Institute of Cultural Anthropology and Development Sociology, she lectures in anthropology and development and environmental anthropology. At the HHS, she is a coordinator and lecturer of Sustainable Business program and a researcher in the fields of environmental education and environmental social sciences. Kopnina is the author of over seventy peer-reviewed articles and (co)author and (co)editor of twelve books.